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Credit risk determinants analysis: Empirical evidence from Chinese commercial banks

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Msc Risk Management

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Abstract

In order to investigate the potential determinants of credit risk in Chinese commercial banks, a panel dataset includes 342 bank-year observations from 2003 to 2012 in Chinese commercial banks are used to quantify the relationship between the selected variables and Chinese bank's credit risk. Based on several robust test, the empirical results suggest the inflation rate and loan loss provision is significantly positive to Chinese commercial banks' credit risk, on the other hand, market interest rate, exchange rate , unemployment rate, bank size, regulatory capital and bank's management efficiency are exhibit a significantly negative relationship between the bank's credit risk. However, the real GDP growth rate has no significant effects on credit risk in Chinese Commercial bank market. Furthermore, after adding two dummy variables, which control the nature of ownership structure and the 2008 global financial crisis, into the model, the results indicate state-owned banks are will take on more risks than the others, however, the 2008 global financial crisis has no significant impacts on the credit risk level in Chinese banking industry.

This dissertation fills a gap in the literature of determinants of Chinese commercial banks' credit risk, through combined the macro- and micro (bank-specific) variables together, the resulted model can be beneficial for the banking practitioners to have a better quantified model to analysis the credit risk in the future.

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I sincerely express my gratitude to Dr. Robert. Young who has given me invaluable insights and unconditional support when I doing the researches and writing this dissertation. It is my honor to be his student, thanks for his earnest teachings, “Every journey begins with the first step”, and I will bear this in mind in my future life.

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Chapter 1: Introduction

"If you owe the bank $100, that's your problem. If you owe the bank $100 million that's the bank's problem."

--John Paul Getty

Credit risk is one of the oldest forms of risk in the financial markets. The Basel Committee on Banking Supervision (2000) defined the credit risk as "the potential that a bank borrower or counterparty will fail to meet its obligations in accordance with agreed terms". For the most banks, loans are the largest part of the bank assets, therefore the credit risk is the most important and primary risk in banks. Since credit risk can causes the potential of exterminate enough of a bank's capital then force the bank into failure, manage the credit risk is the main challenge for running a bank business (Broll, et al., 2002).

As the bank is at the forefront of the financial world, therefore the banks are considered to be the most vulnerable business. Normally, risk is observable when the capital markets is frictionless, thus under the effective risk management, bank's managers can maximize a bank's risk-adjusted return by recognize credit risk thus maintain the bank's credit exposure to an acceptable levels (Kargi, 2011). If the risks cannot be monitored and managed properly, it will result in the failures of banks. The collapse of banks will cause financial crisis. 2008 global financial crisis, which originated in the second half of 2007 from the US sub-prime mortgage market, has caused an increasing volatility in world widely financial markets. MUFG, which is the biggest bank in Japan, is cutting 2,000 jobs at its head office and closing 50 branches due to the financial crisis in 2008 (Nakamoto, 2009). Such a huge losses caused by 2008 financial crisis not only reveals the vulnerabilities of the financial markets but also exposed the poor risk management decisions.

As the development of Chinese economy, together with a proactive fiscal policy and

loose monetary policy, the Chinese banking industry has a rapid expansion in the past few years. Even though China's banking industry has implemented a series reforms in the past three decades, it still far from being a developed, efficient system when compared with the foreign developed banking system and there still have many problems do not really resolved, such as administrative intervention from government, irrational allocation of resources, the pattern of the old regime and institutional issues (Cheng, et al., 2013). From the bank's perspective, the weak risk management and internal control lead to bank risk at a prominent position, especially the high non-performing loans ratio. A high proportions of non-performing loans lead to Chinese banks with a serious financial fragility (Bonin and Huang, 2001), the non-performing loans have reached 1.002 trillion Yuan in "Big Four" banks, which is account for 25.6% of all loans, in June 1997. After china joined the World Trade Organization in 2001, as the discriminatory restrictions of foreign banks were gradually disappeared, Chinese domestic banks are facing an increasing pressure of competition. Thus how to narrow the gap between foreign developed banks and improve the market competitiveness is becoming a major challenge faced by Chinese commercial banks.

The effective credit risk management level of a commercial bank can be determined by the quality of credit assets. A poor credit risk management will lead to the large amount of Non-performing loans of banks, and finally lead banks into bankruptcy. As the Economist magazine declared in the end of 1990s, according to the contemporary non-performing loans and capital, China's four state-owned banks should be bankruptcy three times (Cheng, et al. 2013). Thus non-performing loans will directly affect the stability of Chinese banking sector. In order to maintain the stability and healthy of Chinese financial markets, how to improve the loan quality thus lower the Non-performing loans has attracted much attention among Chinese banks.

The study for investigate the determinants of credit risk in Chinese commercial banks is important since based on a clear relationship between those factors which might

influence the credit risk, the government and bank managers can implement the corresponding policy to maintain the Chinese banking industry in a stability level. According to KMV and CreditMetrics model, the credit risk is affected by the borrower's characteristic such as the asset value and volatility of asset returns, the effects of industry, geography and the size of firm. Moreover, the Credit Portfolio View model describes that the default probability is driven by the macroeconomic factors, e.g. interest rate, exchange rate and GDP growth rate.

Moreover, most of previous studies have investigated the determinants of bank's credit risk, the explanatory variables are focus on macro-economic determinants or bank-specific determinants separately, but not too many studies combine those two classes together, Rinaldi and Sanchez-Arellano (2006) analyze the household Non-performing Loans based on several macroeconomic determinants for a panel of European countries, which are disposable income, unemployment and monetary conditions. Berge and Boye (2007) find the problem loans are highly affected by the real interest rates and unemployment in Nordic banking system over the year 1993 to 2005. Other similar studies focusing on the macroeconomic determinants of credit risk include Nkusu (2011), Boss, et al. (2009). On the other hand, Berger and DeYoung (1997) focus on the relationship between bank-specific characteristics, e.g. efficiency indicators, with problem loans. It can be concluded that the bank credit risk can be affected by three main aspects, the macroeconomic conditions, bank-specific factors and the counterparty characteristics. To my knowledge, in the Chinese context, there are few studies of empirical credit risk determinants analysis. This study will contribute to fill this gap and explore the determinants of credit risk in combined with both Macroeconomic variables and bank-specific variables together. Furthermore, as the ownership structure fundamentally determines the corporate governance mechanisms and behavior choices, thus the effects of the ownership of commercial banks credit risk will be discussed in this study. At last, the relationship analysis between the global financial crisis and the Chinese commercial banks credit risk taking will be involved in this study as well.

As the purpose of this study is to investigate the potential determinants of the credit risk thus examines their relationship and effectsto credit risk in Chinese Commercial Banks.A quantitative research method will be used, which by means of gathering the data from various sources and the determinants of credit risk with their relative proxies which are based on a range of theory, a panel data set will be produced. The determinants will be analysed in this study is "Panel data regression". Under this approach, one of three types of regressions will be used: (1) Ordinary Least Square, (2) Random Effects or (3) Fixed Effects, several robust tests will be used to determinewhich approach will be the most appropriate one.

An unbalanced annual panel dataset with 64 Chinese commercial banks are collected from the annual balance sheet and income statements of commercial banks from Fitch IBCA/Bureau van Dijk'sBankScope database (Fitch IBCA) was employed in this study, the ownership information are from the China Banking Regulatory Commission, and the macroeconomic data from the Chinese Almanac of Finance and World Banks. The dataset spans over the year 2003 to 2010.

The rest of the dissertation is organized as follows:

Chapter 2 describes the background of Chinese economy and banking system. Moreover, as the Chinese banks manage the credit risk depend on both national policies and international standards, the Basel Accords published by the Bank for International Settlement (BIS) will be introduced in this chapter.

Chapter 3 describes an extensive literature review which includes the economic theory of credit risk, credit risk measurement and the previous studies relevant to credit risk determinants, describes the relevant economic theory of the bank's credit risk.

Chapter 4 in conjunction with the literature review then identifying the variables and their relevant proxies, theoretical and empirical aspects will be merged with the methodological approach of this research. After introduce three regression estimation techniques, hypotheses will be set up based on the potential relationship between credit risk and explanatory variables, the descriptive statistics of the data also will be introduced in this chapter.

Chapter 5 will summarizes the regression results and then discuss the results in detailed. The findings not only include the impacts of macroeconomic and bank-specific variables, but also through adding two dummy variables into the model to investigate the impacts from the ownership structure and 2008 global financial crisis.

Chapter 6 concludes with a critical evaluation and conclusion of the research. Limitations of the dissertation and recommendations for the future improvement will also be discussed.

Chapter 2: Background

This section provides background necessary in understanding the empirical modeling of Chinese commercial banks credit risk. It consists of the discussion of Chinese economic development over the past decades in China, a brief overview for the Chinese banking sector and 2008 global financial crisis. Furthermore, international regulations framework, Basel Accords, are also discussed in this chapter.

2.1 Chinese Economy development

China started its transition from planning to market economics in 1978. Gradual economic transition has allowed China maintain a significant rate of growth and to smooth the private sector integration into the global economy. Over the past two decades, the Chinese economy grew phenomenally after access into the World Trade Organization (WTO) on 2001. The average growth rate of GDP is 10.46 percent over the past 10 years. **Figure 2.1** shows the real GDP growth rate from the year 2003 to 2012. As the end of the 2012, China's nominal Gross Domestic Product reached 8.227 trillion US dollar, which is the second largest economy in the world. According to the World Bank estimation, China now is the second largest trading nation in the world. In China, the export has started contributing significantly to growth of economy, as shown in the **Figure 2.2**, the average export is above 33.53 percent of GDP, the booming trade surplus fuelled economic growth over the past years. However, the export suffered a difficult time after the 2008 global financial crisis, which has a significantly restrained the global demand. The net exports fell 44.8% estimated by the Chinese government in year 2009, which affect the economy as a 3.9% decrease of GDP. In November 2008, Chinese Government launch a fiscal stimulus, which include 4 trillion RMB (about 586 billion US dollar), consequently, Chinese GDP growth rate maintained at 9.2 percent in 2009.

The huge achievement in economy growth are also supported by massive investment from the banking sector, especially in the post- 2008 global financial crisis, given lack of well functioned capital market in China (Deng et al, 2011). Chinese banking system play an important role in Chinese economy development as it can be treated as a fiscal agent of government by policy lending. Especially for the China's state-owned banks, a large amount of lending flow into the largest non-financial state owned enterprises (SOEs). Many state owned enterprises invest their loans into the real estate purchases, and thus expanding housing development activities in 2009. Real prices of property have been increased about 225% over the past ten years (Wu et al, 2010).

Even China economy achieved a huge development in the past several decades. There still has several imbalances problem. Compared with the SOEs, according to pre-tax return on equity (ROE), private firms is more profitable than SOEs. Furthermore, private firms have a lower level of indebtedness and a lower debt/equity ratio. (Bongini, et al., 2009). Even though, private companies are still face the difficulties in their access to bank credit. Furthermore, as a response to the global financial crisis, investment has been allocated on the basis of central and local government guidelines, and mainly financed through SOE's loans, while small and medium enterprises, the main component of the private sector, have a more limited access to finance despite the lending expansion (Dorrucci, et al, 2013).

The rapid credit growth and rising property price draw more attention to the amount of lending and asset quality of banks. In Bloomberg report, it indicate that Chinese banks are told by the regulatory that they have not set sufficient funds to cover the losses on loans to local government financing, thus make them to accelerate more debt collection (Somayaji, 2011). According to Pitsilis et al. (2004), on year 2004, SOEs were receiving about 65% of total loans, even if the contribution of SOEs to Chinese GDP was around 25%. Compared with the private companies, the relative figures are 20% and 45%, respectively. The public ownership can be seen as one of

the reason for the fragility of Chinese banking.

Figure 2.1 China Real GDP Growth Rate 2003-2012

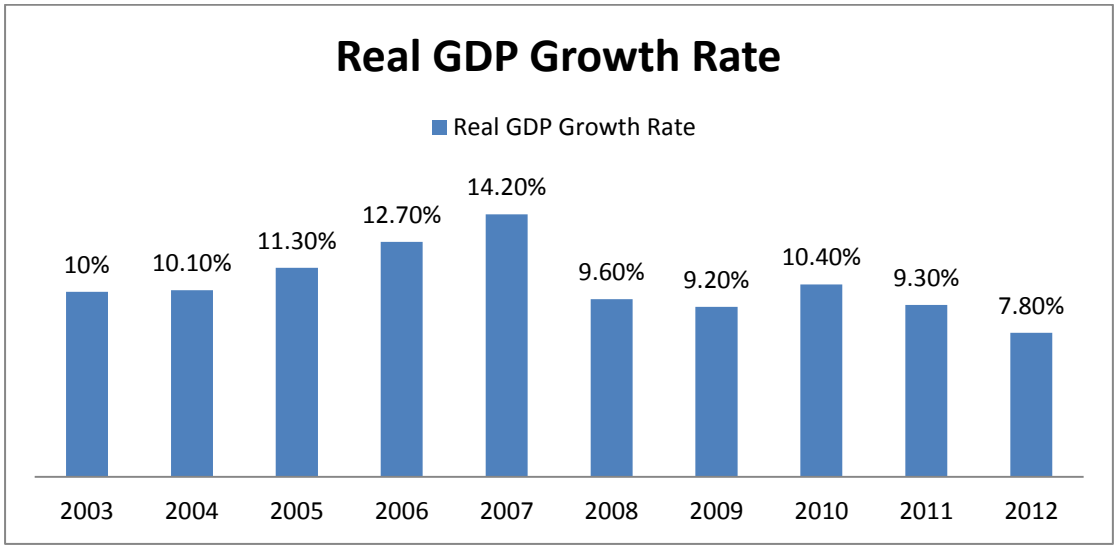
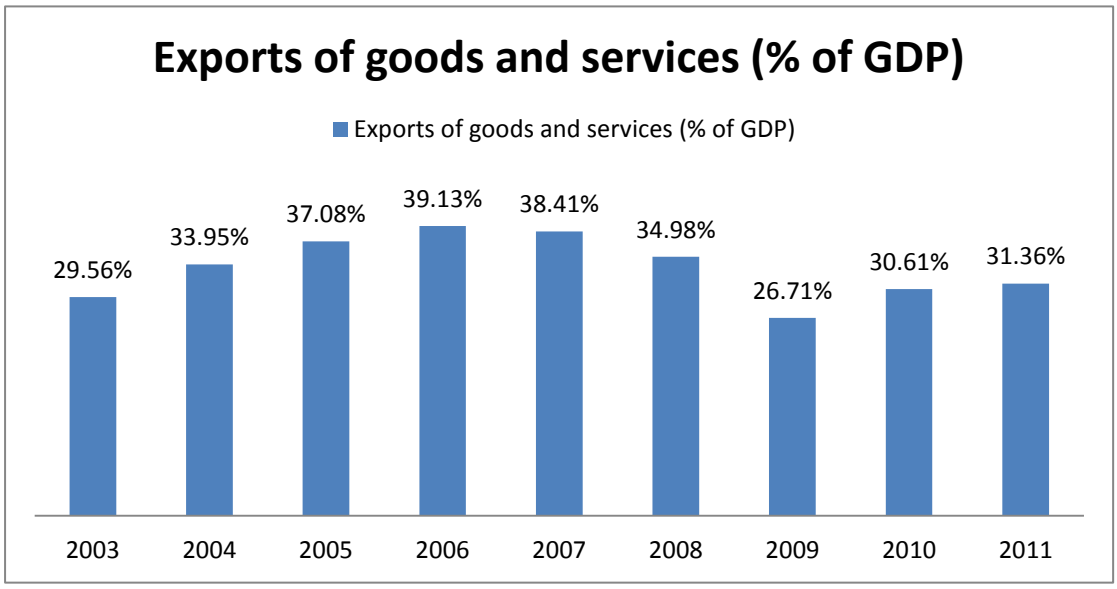


Figure 2.2 Export of Goods and Services (% of GDP)



2.2 Chinese Banking Sector

In the past three decades, Chinese banking industry has experienced an extraordinary reform process. Before Chinese economic reforms started in 1978, the Chinese banking system is mainly controlled by the government and isolated from the global

economy (Martin, 2012). Through such a reform process, the Chinese banking industry has been transformed from a mono-bank model into a multi-bank model, thus from a monopoly to competition and from long-term isolation to relatively open, both the Chinese banking system and Chinese economic are promoted.

The first ran of the banking reform was from 1978 to 1986, during this stage, a new policy implemented by government to required the banks to take over the financing function from governments, which lend money to State-Owned enterprises without any interest rate charges. In other words, the central banks granted the deposit and lending business to newly established state-owned specialized banks.

The second phase of reform implemented from the 1986 to 1994. The Provisional Rules Governing banks, which were promulgated in 1986, listed the division of business among central bank, state-owned specialized banks, and other financial institutions. The Rules admitted that the banking system had changed from being a one-tier system, with the People's Bank only, to a two-tier system, which with the People's Bank and specialized banks and other types of financial institutions. New financial institutions were permitted entry into the banking market, most of them are set up as joint-stock banks (Li, 2011).

However, the state-owned specialized banks managed the credit risk ineffectively, and the lending activities are intervened by the local government seriously, a large amount of loans were issued on a political basis and with a lower charged interest rate (Li, 2011). Under these adverse conditions, the third stage reform with aims to help the commercial banks to grant commercially-oriented loans was begun in 1995, the Act *of the People's Republic of China on Commercial Banks 1995* and the Act of the *People's Republic of China on the People's Bank of China* was implemented, similar to the Basel Accords, the key aim of those two acts is to improve the awareness of credit risk for banks during the lending process, therefore to make commercial banks more responsible for profitability then lead to bank conduct a more prudential

operations .

2.3 Different Types of Chinese commercial banks

Ownership structure of commercial banks can determine the corporate governance mechanisms and the behavior choices, therefore affects the bank's performance and risk-taking (Cheng, et al. 2013).

There are several types of bank operate in China. The first type is the wholly state-owned banks. The second categories includes "equitized" commercial banks (state-owned commercial banks), which normally the Chinese central government is the largest stockholder. After the reforms of banking system, five of the previously state-owned policy banks were transformed into the joint-stock companies, the majority of shareholders for those state-owned commercial banks are the People's Bank of China (BOC), the Ministry of Finance (MOF), or other government entities (Michael, 2012). The third type consists of a variety of local banks, which provincial and municipal as the major stakeholder. This types of banks includes a variety of financial institutions, the largest portion is City commercial banks. The fourth category encompasses of Chinese joint-stock commercial banks which with a lower levels of government ownership. Furthermore, as China joined the World Trade Organization (WTO) and the discriminatory restrictions on foreign bank entry was removed on December 2006 (Cheng, et al, 2013), made many foreign banks enter into the chinese financial market. At the end of 2008, 30 foreign-owned banks have been registered in China; 75 banks from 25 countries and regions have 153 branches in China; 196 banks from 46 countries and regions have established 238 offices in China. (Cheng, et al. 2013).

2.4 2008 Global Financial Crisis

The prolusion of the 2008 global financial crisis was the 2007 U.S subprime Mortgage Crisis (Naudé, 2009). Before 2007, the mortgage industry was thriving and the sub-prime market had a dramatically development. Sub-prime loans are simply loans that would not be lending to borrowers under normal standards (Bessis, 2010). Compared with other types of mortgages, sub-prime loans are collateralized by real estate property and it rely on the expectation that house price will goes up, therefore with the more valuable collateral, transform the sub-prime loans in a prime mortgage. Under the favorable economic environment with a low interest rate, large capital flows, people are over optimism to the market. At the beginning, the subprime mortgages only accounted for 1% of the world's debt stock and 9% of U.S new mortgage, therefore it is assumed to have limited effects on the national and world economy (Persaud, 2008). Finally, as the house booming in U.S which had been formed under the 7% annually increasing, the house mortgages rose significantly, also it consisted a large amount of subprime mortgages (Bullard et al, 2009), Due to the default probabilities of mortgages were underestimated, finally led to unreasonable pricing (Shefrin, 2009).

In the mid of 2007 the housing price began to decline , as the investors began to doubt the real value of the structured securities which were based on the real estate collateral, many of these financial assets are traded and thus lead the prices started to fail, and finally caused a worldwide financial crisis. The collapse of economy bubble and Sub-prime crisis began with unemployment ratio goes up and difficulties for both banks and households in restoring in their balance sheet. Thus finally atrophies the whole economy. The U.S sub-prime crisis soon spread to a world-wide range. As the stock market fall over the world, some developed countries' governments had to bail out their financial systems. At the end of 2009, the U.S government had already spent $9.7 trillion in bailout packages, and European countries spent more than $2 trillion to reduce the effect of such economy decline (Shah, 2010).

2.5 Basel Accords

As the development of globalization and increasing in the world widely banking activities, in order to meet the need of the international cooperation in bank regulation and the Basel Committee on Bank Supervision (BCBS) promulgated several guidance on issues which are important to keep the health of banking systems over the world, the Basel Accords were produced. The foundation of the Basel Accords is the capital adequacy principle, which ensures the banks maintain a sufficient capital level. Furthermore, it also can level the competitive positions of banks in different countries. Basel Accord I, Basel Accord II, Basel Accord III will be briefly introduced in this section.

2.5.1 Basel I

Basel I was published by the BCBS in 1988, then enforced by law in 1992 (Bessis, 2010). It set a series minimum capital adequacy requirement for banks. Basel I use the capital to risk-weighted assets ratio to determine the bank's capital adequacy. Under Basel I, the bank capital can be classified into two categories: Tier 1 and tier 2 capital. Tier 1 capital can be also called "core capital", it consists of highest quality and cost capital, e.g. common stock and cash and the items with a lower repayment priority in the case the bank goes to bankruptcy. Tier 2 capital is lower quality than tier 1, it includes the fund that available but not entirely controlled by the bank. Bank's capital aims to provide a cushion to the losses in the bank's asset. Basel I require a bank to be considered have a sufficient capital it should hold a capital ratio of 8%, which means the value of bank's capital had to equal at least 8% of the value of the bank's risk-weighted assets, however, Basel I also required that tier 1 capital should account half of this 8%.

Basel I established four risk categories for the assets held by commercial banks into

four categories (0%, 20%, 50% and 100%), it determined the proportion of that asset's value would be included in the Risk-weighted assets, according to Basel I, riskier assets will account for more in a bank's Risk-weighted Assets value, while means an increase in the bank's capital requirement. For example, holding cash have will have no loss for banks therefore all cash will be placed into 0% risk category. Similarly, a loan made a Organization for Economic Cooperation and Development (OECD) member country was expected as at a low-risk then it will placed in the 0% risk category as well. However, assets such like commercial loans, e.g. loans lend to business are considered as high-risk and according to the Basel Accords I, it should be included into the 100% risk category.

The Basel I had been criticized since it was published. Firstly, the agreements of Basel I was "not legally binding, undermining its effectiveness" (Hall, 2008). Secondly, Basel I is the risk-weighting system is arbitrary and not nearly sensitive enough to the unique risks associated with each asset held by a bank, e.g. not all the commercial loans borrower share the same amount of risk. According to Bessis (2010), the author point out that Basel I was not sensitive enough due to the minimum capital requirement was both for large and small banks.

2.3.1 Basel II

Basel II was organized by BCBS in 2004, with the aim of complementing and corrects the drawbacks of Basel I. The Basel II accord use three approaches, also be called as "three Pillar", to address the credit risk problems of banks. Pillar I addresses the capital adequacy problem, Pillars II and Pillars III deal with supervisory review process and market discipline issues, respectively. The capital adequate ratio for Basel II is the same as the Basel I, which requires the bank total capital equals to at least 8% of the bank's risk weight assets. Tier 1 capital should have more than a half (4%) of risk-weighted assets.

Pillar I include three approaches to measuring credit risk: the Standardized Approach, the Foundation Internal Rating-Based Approach (FIRB), and the Advanced Internal Ratings-Based Approach (AIRB). The standardized approach for risk-weighting is not the same with Basel I's in several ways. Basel II's standardized approach expands risk categories from 4 to 6. The standardized approach is suitable for the banks without enough credit rating capacity, furthermore, to solve the problem that there is no two assets share same risk profiles, the Basel II standardized approach attempt to make the risk-weighting determination according to the unique risk associated with each of the bank's assets, it determine which bucket an asset is placed according to the credit-rating agencies. Furthermore, the risk-weighting an asset not only depends on asset's credit rating, but also on what does the assets represent. For example, under the Basel I, all the commercial loans will be placed at a 100% risk bucket, however, in Basel II, the commercial loans with a higher rating from the Standard & Poor, say AAA, will be placed in the 20% risk categories.Moreover, a given credit rating is different between the government asset and private party, a government asset will in a lower category even the credit rating is the same with private one. Compared with other two approaches, the standardized approach is the one requires the simplest calculation but with the highest capital burdens (Bessis, 2010).

The FIRB and AIRB approach encourage the banks develop their internal rating for their assets. So these two approaches are much more suitable for the large banks which have capacity to implement them. Banks can anticipate and prepare for the expected future losses through analyzing the historical loss rates. Banks can set aside reserves for those expected losses, e.g. loan-loss reserves, to absorb the losses. But there are some losses are greater than usual, we call these above average losses are unexpected losses, the regulatory capital are meant to cushion such a unexpected losses. In order to estimate the unexpected losses, four inputs are needed: (1) Probability of default (DP) (2) Loss given default (LGD) (3) Exposure at default (EAD) (4) Maturity of the asset: (Bessis, 2010)

Banks use these four inputs to estimate the unexpected losses, thus ensure to set aside a minimum capital equal to 8% of this amount.

2.3.2 Basel III

In September, 2010, The BCBS published Basel III in the response to Global financial crisis. The Basel III does not replace the Basel II, According to Bank of International Settlement, the aims to Basel III is to improve the banking sector's ability to absorb losses from the financial and economic distress without affecting the rest of the economy.

To be more specific, the structure of the three Pillars is unchanged, For the Pillar 1, Basel III retains the tier 1 and tier 2 capitals, but claims the composition of those two capitals should have a greater quality thus can better to absorb the losses. Under the Basel III, tier 1 must be the primarily of "core capital", which includes the equity stock and retained earnings. Furthermore, some items in Basel II formerly included in a bank's capital calculation will not qualify as "capital" any more in Basel III and will be phased out of the calculation of bank's capital in a ten years period starting in year 2013. On one hand, Basel III increase the quality of the capital, on the other hand, it increases the amount of the capital banks have to hold. The regulated countries are expected to fully implement Basel III in 2019, and the total capital ratio will expect to 10.5%, 2% increased compared with the 8% capital requirement under Basel II. Basel III requires bank have to keep the amount of tier 1 capital ratio at 6% of risk-weighted assets. Furthermore, banks must hold more core capital. "Core capital" is a kind of tier 1 capital which consists of common equity, therefore it represents the highest quality capital. Basel III require the bank have to hold the core capital equal to 4.5% of total risk-weighted assets, whereas the core capital only represent 2% of total risk-weighted assets on the previous Basel Accords.

Chapter 3: Literature Review

3.1 Economic theory of Credit risk

Basically, credit risk is part of market risk, it shares the most same channels followed by other forms of market risks and also operates through other mechanism. But there are still some of distinctions between market risk and credit risk, for example, there are illiquid contracts for which market prices are not available. In this section, we focus on the economic principles of the credit risk.

3.1.1 Adverse Selection

Suppose in the business of lending, the borrower are expected to know more than the lenders, e.g. banks, about the credit characteristics of themselves, banks then will at an informational disadvantage condition. According to the FitzRoy,F (1998), asymmetric information exists when on a agreement, at least one party has better information than others are lacking in some dimension of the agreement. If one party to a contract has private information, when at the negotiation time, it is potentially can reduce the value of the contract to the other one due to the information asymmetry, such situation is called adverse selection.

According to Darrough and Stouhton (1986), they conclude that under the adverse selection, the borrower has more information than the banks, such an information gap before sign the actual loan contract may ultimately affect the diagnosis of the credit risk for banks. Berndt and Cupta (2009) indicated that compared with the already established borrowers, new credit relationships have a higher probability of the adverse selection, the banks have more unobservable information for the new borrowers.

Banks attempt to compensate such potential risk by increasing the interest rate of borrowers or schedule the borrowing rate increases with the size of loans. But some borrowers still willing to pay the loan with a higher interest rate, they privately conscious that even with the high interest rate, it is still attractive with their poor credit quality. A high interest rate compensates the effect of the adverse selection, in the meanwhile, it means almost no borrower finds a loan attractive and the banks would not make profit.

Based on the variation in credit risk over the population of the borrowers, limit access to credit seems more effective, although the adverse selection could still occur on some level, the banks can make profit on average, which based on the distribution of default risk and private information in the population of borrowers. According to such principle, banks will have a limit profits by setting a smaller quantitative exposure limits while a lager limit will encourage adverse credit quality. Therefore an "optimal" limit is important which can trades off these two effects for banks. Furthermore, the quantitative limits should be based on information available on the credit quality.

3.1.2 Moral Hazard

According to Felix (1998), "Moral hazard occurs when one party's actions are imperfectly observable and affect the value of the exchange to other parties." It is obviously to see that the information asymmetry is the backbone of the moral hazard. The term "Moral Hazard" derived from the insurance industry and used for describe the situation where, once the individual is insured against certain risk , the insured will put less effort to avoiding the same risks. For the bank's lending activities, informational advantages may enable borrowers engage in the activities that are undesirable from the lender's view because such activities will make the loan less likely to repaid then harm the interest of the lender.

For the banks, normally large loans are expected to be more risky than small loans, one reason is due to the moral hazard problem, it induce the borrower with larger loans have incentives to undertake riskier behaviour. The U.S. savings-and-loan debacle in 1980s, which is a consequence of the savings-and-loan institution can access to extensive credit under federal deposit insurance, on the other hand, without sufficient limits on the riskiness of savings-and-loan investments encouraged some savings-and-loan owners to take on more risky assets. Pennacchi (1998) indicated that the information asymmetries especially for the moral hazard problem arises due to banks are lack of implement expensive monitoring and screening process. Furthermore, the 2008 Global financial crisis which is originated from the U.S subprime mortgage market, has a worldwide effect on many banks, for the purpose of maintaining the stability of financial market, the European Central Bank provided 131 billion dollars of extra funds to the money market (Anonymous, 2007a). It is arguable whether such a bailout from the central government is correct or not.

3.2 Credit risk measurement

In the past three decades, revolutions for the credit risk measurement techniques have been taken place. As credit risk measurement is a key component in a bank's risk management process, the traditional and modern credit measurement techniques will be briefly discussed in this chapter to make a deeper understanding of credit risk.,

3.2.1 Traditional credit risk measurement model

Experts system

Almost 30 years ago, most of financial institutions relied solely on 'expert' systems based on subjective analysis to the credit risk of the corporate loans assessment. To

reach such a subjective judgments, the banker should weighting of certain key factors, a classical expert system is the five "Cs" system, the expert analyze these factors which related to the counterparty and market, subjectively weights them, finally reaches a credit decision. These five "Cs" are: (Saunders and Allen, 2002)

1. Character, which describes the reputation of the debtor, the willingness to pay and past repayment records.
2. Capital, which describes the equity contribution of owners and its leverage ratio.
3. Capacity, which describes the borrower's repayment ability, and the volatility of earnings.
4. Collateral. In the event of default, a banker has claims on the collateral pledged by the borrower.
5. Cycle (or Economic) Conditions, which indicates the status of the economic conditions.

The subjective weights based on the five "Cs" systems by an expert can vary from different borrowers, this is due to such a system are considerable subjective and arbitrary, there is no standard criteria for the optimal weights for the borrowers. This makes the evaluation of the credit risk is lacking of the consistency. Not surprisingly, financial institutions have increasingly moved away from the expert systems over the past 30 years.

Credit-scoring system

Credit scoring systems can be applied to analysis any types of credit, from consumer credit to commercial loans. The idea of the credit-scoring system is that pre-identify certain key factors which can be used as determination of the probability of default, then weight them into a quantitative score. The score represents the probability of default (PD) of a borrower's risk measure. If the score with its attained value is higher

than a critical value, a loan applicant is either rejected or subjected to increased scrutiny. In some cases, the score can be literally interpreted as a probability of default. In others, the score can be used as a classification system, it can put the borrowers into the different risk levels based on a score and correspond critical value.

There are at least four methodological forms of multivariate credit-scoring models: (1) the linear probability model, (2) the logit model, (3) the probit model, and (4) the discriminant analysis model. Altman (1968) suggested one of the most famous credit-scoring models, the Z-score model, which is a classificatory model for corporate borrowers. The equation below shows the best-fitting model for commercial loans:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

Where X_1= working capital/total assets ratio;
X_2= retained earnings/total assets ratio;
X_3= earnings before interest and taxes/ total assets ratio;
X_4= market value of equity/book value of total liabilities ratio;
X_5= sales/total assets ratio.

If the firm's Z-score below the critical value, which in Altman (1968) initial study, 1.81, the firm have a high probability of default then will be classified as "bad" and the loan would not permit to grant, if the Z-score higher than 2.99, then the firm has a low probability of default. The value between 1.81 and 2.99 is the "zone of ignorance", Z-value in this area cannot be effectively judged. (Altman, 1968) However, the choice of the optimal cut-off point can be adjusted with the fluctuation of economic conditions, e.g. if the economy is expected to during a recession period, the cut-off point could be raised so that the probability of granting bad loans will be decreased. This reduces the model's type 1 error, which is lending to bad customers, but increases the model's type 2 error, which is the likelihood that good customers

will be denied credit (Saunders and Allen, 2002).

A number of limitations for the credit-scoring system should be paid more attention here. Firstly, the model is linear while the path to bankruptcy may be highly nonlinear. Secondly, this model is essentially based on the accounting ratios, in terms of the market value of equity in the leverage ratio, most of countries use accounting data which only measured at incountinuous intervals and are generally based on the historical or book-value accounting principles, it is questionable whether the model can pick up a firm that is in deteriorating process.

3.2.2 Modern credit risk measurement model

Unlike with the traditional credit risk measurement, modern credit modelling techniques can be better adapted to the changes of the markets. Such modern credit risk modelling includes KMV-Merton Model, CreditMetrics model, CreditPortfolio View model, Creditmodel and CreditRisk+ model.

CreditMetrics model

Credit Metrics model was first published in 1997 by JP Morgan, the model uses the Value at Risk (VaR) to evaluate and assess the risk of loans, and such an approach is based on the credit migration analysis, e.g. the probability of one credit quality moving to another, it also includes default, for a specific time horizon. Therefore, the core idea of this approach is the value of risk is not only affected by the default of the creditor, it also influenced by the risk rating changes in the following year. CreditMetrics simulate the full forward distribution of the values of any loan or bond portfolio, e.g. 1 year forward, the changes in values are only related to the credit migration. Then Credit-VaR is gotten from similar method as for market risk, it is simply the percentile of the distribution for a given time period at a given confidence

interval, which reveals the maximum possible credit assets loss.

The CreditMatrics model should be used with a specified rating system, the rating system should include the different rating categories, the probability of migrating from one credit quality to another. Due to the CreditMatrics approach only depends on the credit migration, a transition matrix will be the key component of this model. The transition matrix can be Moody's, Standard & Poor's or the bank's private internal credit risk rating system. **Table 3.1** is a transition matrix provided by Standard & Poor credit rating agency.

Table 3.1 Standard & Poor transition matrix (within 1 year)

Initial	**Rating at year-end (%)**							
rating	AAA	AA	A	BBB	BB	B	CCC	Default
AAA	90.81	8.33	0.68	0.06	0.12	0	0	0
AA	0.70	90.65	7.79	0.64	0.06	0.14	0.02	0
A	0.09	2.27	91.05	5.52	0.74	0.26	0.01	0.06
BBB	0.02	0.33	5.95	86.93	5.30	1.17	1.12	0.18
BB	0.03	0.14	0.67	7.73	80.53	8.84	1.00	1.06
B	0	0.11	0.24	0.43	6.48	83.46	4.07	5.20
ccc	0.22	0	0.22	1.30	2.38	11.24	64.86	19.79

Source: Standard & Poor's Credit Week (15 Apr, 1996)

As Aver (2008) stated, a good risk measurement should consider the link between the market and credit risk. According to the CreditMetric technical document, bank credit risk may be affected by the systematic risk, which reflected in changes in interest rates, stock index, exchange rates and unemployment status, etc. But by using a CreditMetrics model it assumes there is no market risk, therefore the only uncertainty in CreditMetrics is the credit migration. Under this method, the credit risk is independent to the market risk. Furthermore, the credit rating for bond evaluation is

based on a strong assumption made by CreditMatricsis that all issuers are credit-homogeneous within the same rating class, as well as the same probabilities for transition and default, e.g. Moody's transition matrix are based on more than 20 years of history of firm, the data is obviously represent average statistics across a sample of heterogeneous firms in different business cycles. For this reason, some big banks prefer to use their own statistics which can be more closed to their loan and portfolios, but for some smaller banks, which cannot easy to access those data, have to rely on the credit rating agencies, the measurement of the credit risk may be biased.

KMV model

KMV model, which is based on Merton's option pricing theory, was published by the KMV Corporation in 1993.

Compared with CreditMatrics model, which is relies on two important assumptions: first, firms within same credit rating share the same default rate. Second, the actual default rate is same with the historical average default rate. In other words, it means the credit rating is same with the default rate. This viewpoint is challenged by KMV. It is true for that the default rates are fluctuates over time, but it will take time for credit rating agencies to adjust the companies default rate when it has changed, therefore such a process is incontinuous. KMV conducted a simulation exercise and indicates that the actual default rate is significantly different with the historical average default rate. Furthermore, KMV has indicated that even for the same bond rating class it still has substantial differences in the default rates, e.g. some BBB and AA rated bonds share the same default probability.

KMV model calculate the Expected Default Frequency (EDF) for each debtor based on the Merton's type model of each firm, therefore the probability of default is a function of the firm's capital structure, the asset return fluctuations and the current asset value. If the firm's asset is higher than its matured liability, then the firm has an

incentive to repay the loan, while if the market value of the assets cannot exceeds its matured liability, the firm may have incentive to default. The KMV model computes EDF based on the fluctuations of the counterparty's stock price, then get the loss given default (LGD) through EDF.

KMV model can be divided into three main steps, firstly, estimate the market value and volatility of corporate equity based on the Black-Scholes options pricing formula. Secondly, based on the book value of the company liabilities, KMV model can calculate the default exercise point and distance default (DD). DD can be calculated as:

$$DD = \frac{MarketValueofAssets - DefaultPoint}{MarketvalueofAssets \times AssetVolatility}$$

DD includes three main components related to credit risk: the firm's assets value, the business and industry risk of the firm, and its leverage. Furthermore, DD also involves the asset value and volatility, the effects of industry, geography and the size of firm (Crouhy, et al., 2000).

CreditRisk+ model

CreditRisk+ model was published by Credit Suisse Financial Products (CSFP) in 1997. CreditRisk+ model only focuses on default probability and default loss. It assumes that default for individual bonds and loans are following a Poisson process (Crouhy, et al. 2000). In this model, it is assumed that:

1. For a loan over a given period, e.g. 1 quarter, the default probability do not changed for other quarters.

2. For a large number of debtors, the probability of default for any specific debtor is small and the number of defaults in not correlated with the number of defaults in any other period.

Therefore, these two assumptions assume that the probability of default is random for each loan in the credit portfolio and there is no correlation between any two loans.

According to the risk exposure, CreditRisk+ divides credit portfolio into several bands with the level of exposure in each bank being approximated by a single number. The expected loss is calculated by average number of defaults times the risk exposure. The Actual Loss is calculated by the number of actual defaults times the risk exposure. Then the loss distribution for each bond will be obtained by combing the default loss and the default probability. After adding the loss distribution of each bond, the loss distribution of credit portfolio can be obtained.

As the CreditRIsk+ only focus on default, and it only requires few inputs, e.g. the probability of default and the exposure. Thus it is easy to implement. On the other hand, CreditRisk+ has its limitations as well, the model assumes no market risk, which is similar with CreditMetrics and KMV models. Furthermore, CreditRisk+ ignores the migration risk, therefore the exposure of each obligor is constant and does not depend on the changes in credit quality and fluctuations of the future interest rates.

CreditPortfolio View

As Crouhy, et al. (2000) stated, CreditPortfolioView model is a multi-factor model to simulate the joint conditional distribution of default and migration probabilities for different rating groups in different countries. According to Ewing (2003), Bonfirm (2009), the business cycle has a significant impact on credit rating transition matrix. Therefore the distribution should be conditional on the value of macroeconomic

factors like the employment rate, the GDP growth rate, the level of long-term interest rates, foreign exchange rates, government expenditures and the aggregate savings rate, this is because the state of economy is driven by the macroeconomic factors in a large extend. So this model applies best to speculative grade obligor.

CreditPortfolioView considers the links between the economy and the casual observation that default probabilities, as well as migration probabilities. When the economy declines both downgrades and defaults increase, it is the contrary when the economy booms.

3.3 Literature review for credit risk determinants

In the previous studies, there have two main trends that the potential factors impacts on the bank credit risk. One trend is most studies focus on the influence of macroeconomic environment on the credit risk, another trend is focus on the effect of the bank-specific factors as potential determinants of the credit risk. This section will discussed either of those two trends.

3.3.1 Macroeconomic determinants

GDP Growth Rates

A majority of studies states that the banks risks are creating from both economic and business cycle. As business and economic conditions is worsening during the recession period, the bank will be more risky than before. During the boom periods, the economic activities are increasing and the volume of cash held for both business and households is increasing, this condition can promote the borrower's repayment ability and then the credit risk of banks can be reduced.

Most studies use GDP growth rates as the main indicator of macroeconomic conditions. A decrease in GDP growth rates can be seen as an decline in income and the decreased debt servicing ability of borrowers.Koch and McDonald (2003) suggest that both borrowers and lenders are confident about the investment and ability to repay the loans during the good economic conditions.

Salas and Saurina (2002) in their report compared the determinants of problem loans between the commercial and saving banks in Spain during the period from 1985 to 1997 , based on a panel data approach the results indicates that the GDP growth rate are negatively affects the problem loans ratio in both commercial and saving banks. A similar result was obtained by Das and Ghosh (2007), they use advanced panel data techniques to examine the factors include both macroeconomic and microeconomic variables affecting problem loans of Indian state-owned banks during the period 1994 to 2005, and the findings indicate that an acceleration of GDP leads to a decline in problem loans. The study conducted by Zribi and Boujelbene (2011) and Daly and Ali (2010) also found the same results which GDP growth has a negatively relationship with the growth of non-performing loans.

On the other hand, Jimenez and Saurina (2006) found that the relationship between the economic cycle and bank risk is dialectical. Kalirai and Scheicher (2002) found there has no significantly impact of GDP growth on the credit risk. Fofack (2005) and Aver (2008) found the similar results.

Inflation Rate

Inflation rate is another macroeconomic factor can be considered as a potential determinant impact the bank's credit risk level. Inflation can depreciates the value of money then reduces the rate of return of the bank. Normally, high inflation rate will lead to a high loan interest rate, since inflation reduces the future value of money, it makes people try to forecast inflation, according to the forecast, banks will adjusting

their interest rate in order to compensate the losses brought by the inflation, if the inflation is not anticipated, the cost of banks may increase faster than bank revenue and then adversely affect the profitability of bank, furthermore, a high inflation rate will increase the obligation of the loan borrowers and finally increase the bank's credit risk.

Gunsel (2008) examined the factors affect the bank fragility in the North Cyprus economy with a panel data contains 24 commercial banks from 1984 to 2008, the results shown that the inflation rate is positively related to the bank's credit risk. The same results is founded by Rinaldi and Sanchez-Arellano (2006), their study examine the impacts of inflation to credit risk in North Cyprus and Euro Zone country. In an opposite side, Zribi and Boujelbene (2011) in their study which investigate the factors influence the bank credit risk in Tunisia banking sector and found that the inflation rate has a negative impact on the credit risk. The same results founded by Vogiazas and Nikolaidou (2011), Shu (2002) and Rinaldi and Sanchez-Arellano (2006) However, Castro (2012) did not found any significant influence of inflation to credit risk.

Unemployment Rate

Unemployment rate is a crucial indicator to reflect the economic conditions. When the number of jobs available in the labor market is insufficient to everyone, the unemployment problem will be increased (Mankiw, 2002). Normally during the periods of economic downturn, a relatively high unemployment rate will appear at the same time. As the unemployment rate increased, which means the labor market is saturated, it should has a negatively impacts on the cash flow streams of households thus finally reduce their loans repayment ability. For the firms, the increases in unemployment conditions indicate that a decrease in production due to the reduction in effective demand, this may lead to a decrease in revenues then lead to a weak debt condition. Louzis et al. (2011) find that the employment rate has a strong effect on the

level of nonperforming loans in the study of the determinants of non-performing loans in the Greek banking sector. Lawrence (1995) suggests due to the unemployment risk increased that the borrowers with low income have higher default probability in loans thus finally lead them cannot settle their obligation. Rinaldi and Sanchez-Arellano (2006) argue that the probability of default depends on current income and the unemployment rate, which is linked to the uncertainty regarding future income the lending rates.

Market Interest Rate

The interest rate can be taken as another driver of bank's credit risk since it affects the debt burden. The changing and fluctuation of the interest rate is important to bank's credit risk because it influences the difficulty of borrowers to servicing the debt. For the borrowers, a rise in interest rate will directly increase the return of newly made or variable interest loans, then it will result in a debt burden increase, for the banks, it will lead to a high rate of nonperforming loans (Aver, 2008). According to the economic theory of asymmetric information theories, higher interest rates will intensify the adverse selection problem, as some borrowers still willing to pay the loan with a higher interest rate, they privately conscious that even with the high interest rate, it is still attractive with their poor credit quality.

Richard (1999) examine determinants of bank failures in the US over the period 1963 to 1991, the results show that there is a significant positive relationship between real interest rate which is measured by three-year Treasury notes minus inflation rate. The same result was founded by Fofack (2005), in his study which investigates the causes of nonperforming loans during the banking crises in sub-Saharan Africa in the 1990s, empirical analysis shows that the real interest rate is significantly positive related with the bank's credit risk. This suggests that the rising interest rate to the extent that the increase of the cost of deposits and then contributed to a decrease in the bank's profit.

Exchange Rate fluctuation

Exchange rate is also one of macroeconomic debates in the developing market, according to the Zammer and Siddiqi (2010), the fluctuation of the exchange rate is one of the main reasons of the economic instability. The borrower's ability to repay the loans is sensitive to the exchange rate. Exchange rate measures the relative worth of the domestic currency in terms of another. (Zammer and Siddiqi 2010). For the firms, the main problem is the regularly appreciation of foreign currencies compared with the local currency, another is the difficulty in retaining native customers due to the price of imported goods and services increasing then finally affect the price of the final products which sold locally. (Sirpal, 2009) As the domestic price of foreign exchange rate rises, it becomes more expensive to acquire foreign product and services and then require more units of domestic currency to buy same quantity of products and services than before. The consequence is an increase in the demand for bank credit to support finances for covering the additional expenditure which resulted by exchange rate depreciation (Ngerebo, 2011), then reduce the firm's profitability. The reduce in firm's profitability cause the firm face the problem to serve the interest and principal of debt.

Zribi and Boujelbene (2011) conducted study in Tunisia banking sector and used ratio of risk weighted assets to total assets as proxy of credit risk then found there is a negative relationship between the exchange rate and credit risk. The same results was founded by Castro (2013), the study found the real effective exchange rate is negatively related to the credit risk. On the other hand, Kalirai and Scheicher (2002) in their study which investigates the relationship between foreign exchange volatility and credit, and found the relationship is ambiguous, no significant relationship.

3.3.2 Bank-Specific Determinants

Even though some of the banks can be subjected to the same macroeconomic conditions in one country generally not all of them have exposed to a same level credit risk, the appropriate and effective bank's management can substantially reduce the bank's credit risk, thus another trend is focus on the bank-specific factors as potential determinants of bank's credit risk. These factors might include as follows: the regulatory capital ratio level, bank's profitability, sources of funds and the nature of the ownership, etc.

Ownership structure of the bank

A large amount of literatures emphasize the ownership structure play an important role in affecting the credit risk of the bank, especially the relationship nature of bank's ownership and the bank's credit risk level. Generally, the State-owned banks are expected to take more risks than the private and foreign banks. (Zribi and Younes)As Li (2011) states that in the reality, banks normally has less incentive to manage credit, especially for the government banks, this is because the State-owned banks surely believe that they would be bailed out by government when bankruptcy occurs so that there have less incentives for them to manage the credit risk. Furthermore, according to Sapienza (2004) concludes the reasons into three aspects for why state-owned banks are exposed to take more risks than others types commercial banks. From the social view,the state interferes aims to correct the market failure brought by public banks. From the political view, the state-owned banks can be used to pursuing politician's private interests. The third reason is that, according to the agency view, the author point out that the state-owned banks are plagued by corruption and resource misallocation.

Fungáčová and Solanko (2008) check into the relationship between bank specific features and risk-taking using quarterly data during the 1999-2007 on all Russian

banks and found that the effect of different ownership structure has a significant influence on the banks insolvency risk. De Nicolo (2001) suggests that the relationship between the state ownership and banks' insolvency risk is positive. According to the Boudriga, et al (2009), their study empirically analyses the cross-countries determinants of nonperforming loans and the empirical results indicate that foreign ownership has positive impact on loan quality because it can promotes imports of human capital, management skills and technologies, furthermore, it also can provides opportunity to raise funds cheaply on international markets, the authors also indicate that State banks have more incentives to involve in risky projects due to the 'too big to fail' problem. Micco and Panizza (2004) investigated how bank ownership affect bank performance in developing countries and found that the state-owned bank have higher ratio of nonperforming loans. Furthermore, as Maechler, et al. (2007) compares the different types of financial risks impacts on the bank stability , the result indicates that the foreign banks tend have a higher risk profile than the domestic banks.

Bank Size

Bank's diversification may also be related with the loan quality. As Gas and Ghosh (2007) states that the larger banks have a more control ability for credit risk than smaller banks because the larger banks might be able to control credit risk better than the smaller banks since the diversification can lower the credit risk, since large banks normally have a larger amounts of the borrowers with variety kinds of businesses, according to the Modern Portfolio Theory, the diversification can lower the unsystematic risk.

Empirical evidence shows that income sources and loan portfolio diversification can be lower the credit risk of banks effectively. First, involvement in operations not associated with credit risk taking, for example, payment transactions, broking, etc which can diversify the income resources, then allow banks to earn less risky income

thus reducing incentives to finance speculative projects. Secondly, banks can reduce the impaired loans through lend money to a widely range of borrowers.

The study of Salas and Saurina (2002) analyze the determinants of problem loans and compared with commercial and savings banks in Spain from 1985 to 1997, the result found the relationship between bank size and nonperforming loans are negatively related, it indicates that larger banks have more diversification opportunities. Hu et al. (2004) analysis the relationship between the bank size and non-performing loans with a panel dataset includes 40 Taiwanese commercial banks during the period 1996-1999 and found that the bank size has a negative influence on the non-performing loans the result support the views that larger banks have more resources and ability to improve the quality of loans. Rajan and Dhal (2003) also report the similar results.

On the other hand, the moral hazard of too-big-too-fail can represent another view of the relationship between the bank size and credit risk. Large banks may take an excessive risk taking to since they expect government protection in case of a bank's failure. (Stern and Feldman, 2004) Consequently, large banks may increase their leverage too much without more prudent consideration and finally extend loans to lower quality borrowers, finally reduce the loan quality.

Regulation Capital

A common belief is that higher capital requirements will lead to a higher stability of the banking sector and then result in a higher stability of the banks and will a lower levels of the bank's risk (Zribi and Boujelbene, 2011)According to the Basel I and II, Banks have to hold a minimum regulatory capital ratio equal to 8 percent of their total risk weighted assets, therefore to avoid the bank failures and protect the rate of return on depositor's fund.

It is widely accepted in literature that low capital ratio is associated with higher

probability of banks' default, because this may induce managers involve in more risky projects. According to the 'Moral Hazard' hypothesis presented by Berger and DeYoung (1997), low-capitalization banks leads to an increase in non-performing loans, a thinly capitalized banks' manager have incentives to increase the riskiness of their loan portfolio. Berger and DeYoung (1997) found lagged capital (measured by equity capital to total assets) indicates various results for different types of banks. They found the lagged capital is significantly negatively related to credit risk in the thinly capitalized banks. The result indicates that banks with lower capitalized are expected to have a higher risk. The similar results was founded by Shrieves and Dahl (1992).

However, Ahmad and Ahmad (2004) find an opposite result which the regulatory capital is negative related with the conventional banks credit risk but positively related with credit risk in Islamic banking.

Management Quality and Bank Efficiency

The relationship between credit risk and bank efficiency is ambiguous in the literature, there is no consensus relationship. On one hand, high values of cost efficiency indicators may reflect the reduction on resource allocated to the risk management process and monitoring of the borrowers, which will leads to a decrease in loan quality. According to the skimping hypothesis proposed by Berger and DeYoung (1997), the 'skimping' hypothesis indicate that high cost efficiency will lead the number of nonperforming loans increasing, this is because a trade-off will be existed between allocating resources for underwriting and monitoring loans and the measured cost efficiency, that means, banks with be more cost-efficient with less effort to ensure the a higher loan quality. The result will lead to a lifeful number of Non-performing loans in the long-run.

On the other hand, low cost efficiency means low level and quality of bank

management, so that an increasing in the problem loans due to the bad management of loans lending. According to Berger and DeYoung (1997), "bad management" hypothesis indicates that low cost efficiency is positively related with the future non-performing loans increasing. Bad management implies poor skills in credit rating, collaterals appraisal and borrowers monitoring.

Podpiera and Weill (2008) examine the causality between non-performing loans and cost efficiency to find whether either of these factors is significantly affect the bank failures. The results support the "bad management" hypothesis and suggest that lower cost efficiency will increase the non-performing loans.

Loan Loss Provision

Loan loss provision is known as an expected loan losses control mechanism. The Basel Accord I defined the Capital is to cover the unexpected losses while the loan loss provision is cover for the expected losses. Banks set aside a higher level of loan loss provision can decrease the earning volatility and enhance the medium-term bank payment ability through anticipating the expected losses. On the other hand, as the banks willing to provision for loan losses can be supposed to a strong belief in the future performance of the bank and managers use it to signal the financial strength of their banks (Ahmad, et al., 1999). The level of provisioning can be considered as the general attitude of the bank toward risk control.

Bikker and metzemakers (2004) investigated how business cycle is affected by the bank's loan provision behavior, the results indicate that banks make substantially high level of provisions to cover the high expected losses when in a economic downturn. Therefore, a higher level of provision reflects a high potential credit risk.

Ahmed et al. (1998) used Loan Loss provision to Total Assets ratio as a proxy for the loan loss provision and found Loan Loss provision is significantly positive associated

with NPLs. Therefore, a higher Loan Loss Provision indicates an increase in credit risk and decline in loan quality. Fisher, Gueyie and Ortiz's (2002) finds similar results which the Loan Loss Provision is positively related to risk. Even the economic environment and develop level of banking system is different, the Malaysian banks show a similar results as their Loan Loss Provision is significantly positive related to credit risk (Ahmad, 2003)

Chapter 4: Methodology

This chapter is to explain the research methodology of the research. The objective of this research is to examine the determinants of Chinese commercial banks' credit risk Therefore, this research will establish a quantifiable relationship between the selected explanatory variables and the bank's credit risk, to assess this, a quantitative research will be conducted in this dissertation. In this chapter, the hypotheses are put forward based on the theoretical and empirical evidence, and justify the selection of variables and choice of estimation method,then develop the appropriate models to exam the determinants of credit risk of Chinese commercial banks.

4.1 Research Econometric Model

As mentioned above, a quantitative methodology is used to analysis the significance of the identified variables. The econometric model which will be employed for this study is based on the "Panel data" or "longitudinal" sets for which each bank will be representing the "cross-section" while also be divisible through a timeline known as "time-series" (Wooldridge, 2012;p.10). Therefore, the basic econometric regression model in this research to examining the determinants of credit risk and the independent variables can be written as follows:

$$Y_{i,t} = \beta_0 + \beta_1 X_{1i,t} + \beta_2 X_{2i,t} + \beta_3 X_{3i,t} + \cdots \beta_n X_{ni,t} + \varepsilon_{i,t}$$

Where

$Y_{i,t}$: Dependent Variable in time t for bank i

β_0: Constant term

β_1 to β_n: Coefficient of independent variable

$X_{1i,t}$to $X_{ni,t}$: Independent variable in time t for bank i

$\varepsilon_{i,t}$: Error term in time t for bank i

4.2 Estimation Techniques

There are several types of panel-data regressions, Pooled Model, Fixed Effects (FE) or Random Effects, the application of which type of method depends on the different tests.

4.2.1 Ordinary Least Squares Estimation

Ordinary Least Squares is one of the most popular methods of all the regressions. when putting all the data together without making any difference between cross section and time series, and the random errors were truly random, positive and negative value of error term would be randomly distributed across banks and years, the regression run over the dataset by using ordinary least squares will be pooled OLS regression. When use a pooled regression approach, it has several advantages. Firstly, the number of observations, degree of freedom can be increased, and it also can reduce the co-linearity problem between the explanatory variables especially there are limited numbers of observations. Secondly, pooling data can controlling the exogenous shocks common to all banks (time effects) and reduce the omitted variable effects (unit effects). Its applicability is explained under the umbrella of the Classical Linear Regression Model (CLRM) where it is assumed that "regressors are fixed or nonstochastic in the sense that their values are fixed in repeated sampling" and are "homoscedastic", where the variance for the error term is deemed constant (Gujarati, 2011). Given this GLRM assumptions, the OLS is the Best (Minimum Variance) Linear Unbiased Estimator under the Gauss-Markov theorem.

However, in regression analysis when several explanatory variables are highly

correlated, the multicollinearity problem will affect the results of the regression model. It will have several symptoms for the multicollinearity problem: (1) when adding or deleting variable(s) or observation(s), there will be large changes in the regression coefficients. (2) The coefficient for a theoretical important explanatory variable will be insignificant, or comes with an opposite sign. (3) Even with a significant F statistic for whole regression and the R-square is quite high, the individual coefficients are insignificant (Koop, 2006). The variance-inflation factor (VIF) can be used to test the multicollinearity problem. As a rule of thumb, if the value of VIF exceeds 10, the dataset will consider have a multicolinearity problem (Wooldridge, 2012; p.94).

Heteroskedasticity is a statistical problem occurring mainly in cross-section studies, because of different sizes of the units, e.g. the profit of large banks are likely to be higher than the profits of small banks, the variance of profits for large banks with a diversified loan portfolio is likely much lower than the smaller banks. Furthermore, the variance of dependent variable will increase as the measurement of the dependent variable gets larger. Thus as the data sample becoming more complicated it has a tendency to heteroskedasticity.

Simple pooled regression may not be optimal to catch the relationships between dependent variable and explanatory variables. Due to the simple pooled model may be biased as it assumes no differences exist between units and it assumes there is no heterogeneity (Wooldridge, 2012; p.444). If there are persistent differences between banks (individual heterogeneity), error term would vary more systematically across firms. E.g. some banks would have high proportion of positive values, while others would have more negative values.

4.2.2 Fixed Effects Estimation

Consider the variant equation as follows:

$$y_{it} = \beta x_{it} + f_i + \varepsilon_{it},\ i=1,2,\ldots,N;\ t=1,2,\ldots,T.$$

Estimating through equation 1 by OLS would be problematic since the heterogeneity term f_i is likely to be correlated with x.

$$\mathrm{Cov}(x_i, f_i) \neq 0$$

Here f_i is called the fixed effect. The fixed effects estimator, which can uses a transformation to remove the heterogeneity term, through eliminate the fixed effect.

Now for each I, average the equation over time as:

$$\overline{y}_i = \beta \overline{x}_i + f_i + \overline{\varepsilon}_{it}$$

Where $\overline{y}_i = \frac{\sum_{i=1}^{T} y_{it}}{T}$ and so on.

Subtract 2 from 1 to eliminate f_i then we can get the model as:

$$\ddot{y}_i = \beta \ddot{x}_i + \ddot{x}_{it},\ t=1,2,\ldots,T$$

Where $\ddot{y}_i = y_{it} - \overline{y}_i$ is the time-demeaned data on y, and similar for $\ddot{x}_i$and$\ddot{\varepsilon}_{it}$. The fixed effects transformation is also called the within transformation. As the estimator is free of endogeneity bias since the correlated effects are elimated, a pooled OLS estimator based on the time-demeaned variables then is called fixed effects estimator or the within estimator (Wooldridge, 2012; p.467)

4.2.3 General Least Squares Estimation

In the fixed effects model, the goal is to eliminate the fixed effects term because it is thought to be correlated with one or more explanatory variables. But if the fixed effects term is not correlated with each explanatory variable in all time period, using a transformation to eliminate the fixed effects term will results in inefficient estimators (Wooldridge, 2012; p474). Furthermore, when the variances of the observations are heteroscedasticity, OLS will be statistically inefficient and give the incorrect estimation. Instead, a generalized least squares (GLS) procedure is usually used. Generalized Least Squares can be used to estimate models with autoregressive serial correlation. The Random effect model, which is also known as the error component model, then is best estimated by Generalized Least Squares (GLS) instead of the OLS.

4.3 The selection criteria of estimation techniques

4.3.1 Random Effects Model or Pooled Model

The differences between the Random effects model and pooled model is that the former model assumes there exists an individual heterogeneity across the units, while the latter one assumes there is no heterogeneity exists. In this research, we will use the Breusch-Pagan test to test for the presence of heterogeneity. The null hypothesis of this test states that “there is no heterogeneity”. So rejection of the null hypothesis would be evidence in the favor of the random effects model.

4.3.2 Random Effects Model or Fixed Effects Model

Models controlling such heterogeneity are called individual effects model-Fixed effects model (FEM) and Random effects model (REM), the key differences between

those two models is that the FE model assumes that the heterogeneity term is correlated with the independent variable, while the RE model assumes the correlation between the heterogeneity term and independent variable is zero.

Due the presence of the heterogeneity across the banks, the fixed effects model and random effects model are better than the pooled model, therefore, to determine the choice between the fixed and random effects models is important issue in this research. If the individual effects (heterogeneity) and the regressors are uncorrelated, the random effects model is the best, while if the individual effects are correlated with the regressors, fixed effects model will be choose and never use the random effects model. To determine which model is more suitable for this research, the Hausman Test will be used. Then under the null hypothesis of "there is no correlation between regressors and individual effects", if the null hypothesis is rejected, Fixed Effects model is applicable. The formula for the Hausman test statistic can be represented as:

$$H = (\beta_{FEM} - \beta_{REM})' V^{-1} (\beta_{FEM} - \beta_{REM})$$

Where,

β_{FEM} is the fixed effects model estimator

β_{REM} is the random effects model estimator

V: Variance (β_{FEM}) − Variance(β_{REM})

4.4 Variables and research models

4.4.1 Dependent Variable

Credit risk- Non-performing loans ratio

In order to investigate the credit risk determinants in Chinese banking sector, it is important to determine the measurement of the credit risk for this research. Based on the previous theoretical part, credit risk can be defined as a risk of loss arising from a borrower who does not make payments as promised, A non-performing loans can be those loans that in default or almost close to default. (Altman and suggitt, 2000) Therefore the Non-performing loans can reflect the quality of assets of a bank's portfolio.

One of the most commonly logical indicators of credit risk is the ratio of non-performing loans (NPL) to total loans. As Peria and Schmukler (2001;p.1035.) stated, NPL ratio can be measures the percentage of loans a bank might have to write off as losses. There are several previous studies, Ahmad and Afiff (2007), use NPL ratio as the proxy of the credit risk, the same method can be found in Berger and DeYoung (1997).Then the credit risk can be represented as the following ratio:

$$\text{Non Performing Loans (NPL) ratio} = \frac{\text{Nonperforming}}{\text{Total Gross Loans}}$$

In China's banking industry, loans can be divided into five categories: normal, special mention, substandard, doubtful and loss loans. Non-performing loans includes the last three categories. A high NPL ratio refers to the more default and the higher credit risk for banks.

4.4.2 Explanatory variables

Gross Domestic Product Rate

Gross Domestic Product (GDP) is regularly used by economists to measure the impact of aggregate economic activity. Hence the GDP growth can be considered as an important macroeconomic determinant of bank performance. A positive growth

indicates to economic booms, while a negative growth refers to the economy recession. During the recessions, the quality of loans decline due to the difficulty for borrowers' repayment. On the other hand, in a period of economy booms, the general economic activities are increase, thus the volume of cash flow for borrowers are increased then lead to an increase of repayment ability. Therefore, changes in the GDP are expected to have impact on the Chinese banking sector. There are two types of GDP, the real GDP and Nominal GDP. The real GDP growth rate which is an inflation-adjusted measure that refers the value of outputs in a given year is selected as a potential determinant in this research.

Hypothesis 1: The real GDP growth rate is negatively related with the Chinese commercial banks' credit risk

Inflation

Inflation can depreciate the value of cash thus reduce the rate of return in general. For the banks, if the anticipation of inflation over a relevant period is fail and cannot adjust the interest rate to increase the revenue to compensate the negative impact of inflation, this will have a negative effect for the bank's performance. Furthermore, inflation also give an incentive to invest, when inflation increasing, people prefer to take on more risk to invest, finally it will increase the default probability of the loans. (Qu, 2008). Moreover, according to the principal-agent theory, a decrease in profit as bank manager failing to anticipate the inflation will lead bank manager to take on extra risk and finally increase the bank's credit risk.

The inflation measured by Consumer Prices (annual %) can indicates the annual percentage changes in cost to average consumer of acquiring a basket of goods and services,thus the Consumer prices (annual %)is used as a proxy for the inflation to reflect the fluctuations in inflation in this study.

Hypothesis 2: The inflation is positively related to the Chinese commercial bank's credit risk.

Market interest rate

The interest rate is a potential important factor which affects the bank's credit risk. An increasing in interest rate may increase the debt burden for the borrowers. Furthermore, in terms of asymmetric information theories, higher interest rate will lead to an adverse selection and moral hazard problem. As stated by Stiglitz and Weiss, the increasing of interest rate will increase the riskiness of bank's loan portfolio from either discouraging the safer investor or inducing the borrowers to take on more risky projects. In this research, Lending rate, the rate normally used by banks to meets the short-term and medium-term financing needs for the private sector, is selected as a potential determinant of the credit risk.

Hypothesis 3: The interest rate is positively related with the bank's credit risk.

Exchange rate

The foreign exchange rate measures the relative worth of domestic currency to other country. It can reflect a country's export and import conditions. As the foreign currency value goes up, the price of imported inputs will goes up which will lead the final products with a lower price advantage for the domestic firms. Even though the international competitors this will lead a lower probability of default as the exporting cost will decrease, but for the Chinese banking sector, due to their major services are face for the domestic producers, the appreciation of foreign currency will lead the decrease of the domestic firm's profitability and their loan repayment ability, finally increase the probability of loans default. As US dollar is the predominant world currency in world trading activities, the exchange rate measured by direct quote for U.S dollar are used in this research. E.g. a direct quote for U.S dollar would be 6.12

Yuan= 1 dollar, thus a increase in exchange rate indicates a depreciation of local currency.

Hypothesis 4: There is a significant negative relationship between the exchange rate and bank's credit risk.

Unemployment rate

Compared with the GDP growth rate, which can be used as an indicator of the economic environment conditions, unemployment rate can give additional information for the regarding the economic conditions impacts (Castro, 2013). As the increase in the unemployment rate, it will indicate that more borrowers may lose their jobs thus provide a negative impact for their income, a decrease of cash flow streams of households and increasing in the debt burden. For firms, increases in unemployment reveals that the decrease in production as a result of dropping in effective demand. Those effects may lead the growth of bank default loans.

Hypothesis 5: Unemployment rate is negatively related with the bank's credit risk.

Bank Size

The size of bank is supposed to be related to the bank's credit risk. Compared with the small banks, large banks have higher control ability for the credit risk as the diversified loan portfolios. According to the portfolio theory, a diversified portfolio can lower the unsystematic risk since large banks normally have a larger amount of the borrowers with variety kinds of business. Furthermore, with a variety of businesses, larger banks are involvement in operations not associated with credit risk taking, it allow banks to earn more stable income thus reducing incentives to take on more riskier activities, e.g. finance speculative projects.

Size is used to capture the economies of scale in the market. As the amount of assets varied differently with highly dispersed range across banks, most of studies use the natural logarithm of total assets as a proxy to measure the size of bank. Through using the natural logarithm, the size can be more homogeneous and easy to compare with others.

Hypothesis 6: There is a negative relationship between bank size and bank's credit risk.

Regulatory Capital

Banks and other financial institutions normally hold a range of asset and each type of assets has its own risk profile. E.g. under the Basel Accords II, mortgage loans which secured with collateral has a 50% weighting of Risk-weighted assets. Regulatory capital is used to cushion the unexpected losses for banks. In accordance with the Basel Accords I and II, banks should hold a minimum capital equal to 8% of their risk-weighted assets, while under the new Basel Accords, the ratio will increase to 10.5% in 2019. Regulatory capital ratio consists of two parts. Tier 1 capital and Tier 2 capital, where tier 1 consists primarily of "core capital". Such a regulatory capital requirement is to ensure the banks have enough capital to cushion the losses in order to meeting their obligations as usual. A higher regulatory capital means the bank have more capacity to absorb the unexpected losses, thus lead to a lower credit risk. In this research, the measurement of the Capital adequacy ratio is similar to Awojobi et al (2011) method, The ratio of capital adequacy was obtained from BankScope in the form as:

$$\text{CAR} = \frac{\text{Tier 1 Capital} + \text{Tier 2 capital}}{\text{Risk Weighted Assets}}$$

Hypothesis 7: The regulatory capital is negatively related to Chinese commercial bank's credit risk.

Bank Efficiency

Efficiency within a bank is important for the credit risk management, it requires banks create more values with a less spend on money. The relationship between the bank efficiency and credit risk is ambiguous in previous studies, one trend assumes bank's put less effort to with less effort to ensure the loan quality will be more cost-efficient, thus there will be a lifeful number of non-performing loans in the long-run. Another trend is that, low cost efficient implies bad management and skills in appraisal and monitoring the borrowers thus lead to increase the bank's credit risk. However, the proxy for the bank management efficiency is adopt the method based on Zribi and Boujelbene (2011) and Awojobi et al. (2011), which are emphasizing on earning assets to total assets ratio based on "management decisions affect the composition of assets which are earning (high) interests" Angbazo (1997).The Return on Average Total Assets (ROAA) is applied as a more rational proxy for the management's efficiency:

$$\text{ROAA} = \frac{\text{Net Income}}{\text{Average Total Assets}}$$

Mishikin (2010) states that " the return on assets reflects how efficiently a bank is being operated, because it describes the amount of profits are generated on average by each dollar of assets." In this study, we suppose the relationship between the bank efficiency and credit risk as follows:

Hypothesis 8: The bank management efficiency is positively related to the Chinese commercial bank's credit risk.

Loan Loss Provision

Loan loss provision can be used to cover the expected loan losses. Banks anticipating the possible levels of capital losses, if the banks expect a growth in risk and deterioration in loan quality, banks will create more loan loss provisions. On the other hand, managers often use loan loss provisions as a signal to the financial strength, the willingness of a bank to set aside provision for loan losses signifies strong belief in the future performance of the bank (Ahmad et al.1999) In this research, to investigate the relationship between the loan loss provision and bank's credit risk, we adopt the approach from the Ahmad And Ariff (2007), use the loan loss provision to total loans ratio as a measurement of the bank's loan loss provision level.

$$LLPr = \frac{LoanLossProvision}{TotalLoans}$$

Hypothesis 9: The Loan loss provision is positively related with the Chinese commercial bank's credit risk.

4.4.2 Dummy Variables

Bank Ownership

To compare the state-owned commercial banks with other types commercial banks and investigate whether the state-owned banks will bear more credit risk, dummy variable will be used in this study. Dummy variables are "essentially a devise to classify data into mutually exclusive categories" (Gujarati and Porter, 2009; p.278). In econometrics, qualitative factors often come in the form of only two possible values, the relevant information can be captured by a binary variable.

A large number of studies indicate that ownership structure might have a significantly impact on the credit risk of the banks. Generally, most of the studies indicate that the

state-owned banks take more risks than other types of banks. The firm's ownership structure can be summarizedinto two main categories: the degree of ownership concentration and the nature of the owner (Iannota et al., 2007). In this research, we adopt the nature of the ownership to measure the ownership structure as the ownership concentration data is difficult to obtain in Chinese banking industry. Our dataset contains state-owned commercial banks, city commercial banks, joint-stock commercial banks and foreign commercial banks, we divided those banks into two dimensions, the state-owned commercial banks and others. Similar to the approach adopted by Cheng et al. (2013), the dummy variable OWN is introduced. OWN equals 1 if the bank is a state-owned commercial bank and zero otherwise.

Hypothesis 10: State-owned banks will take on more risks than other type's commercial banks in China.

Global Financial Crisis

As the 2008 financial crisis are expected to affect the global economy, one of the aims of this study is to investigate whether the 2008 financial crisis has animpact on the Chinese commercial banks' credit risk. The dummy variable, GFC08, will beused to determine the impact of the 2008 global financial crisis on Chinese commercial banks. Through use such a controlvariable to signify the period of the crisis, the dummy variable will take the value of 1 if the observations after year 2008 and 0 otherwise.

As 2008 global financial affected the world economy. The unemployment rate reached 10% in United States and caused a higher level in the Europe and elsewhere. In China, before the 2008 global financial crisis, the GDP growth rate reached an unprecedented high level in 2007, however, as the global financial crisis damage the Chinese exporting sector, which shown in the **Figure 2.2**, the portion of exports of goods and services to GDP decrease sharply from 34.98% in 2008 to 26.71% in 2009, most export-oriented companies will be affected by the reduction of demand. Furthermore,

compared with 2008, the real GDP growth rate slowed almost 5% in 2009. As we expected the downturn in economic condition should have a positive impact on the bank's credit risk which result in limited in liquidity, the non-performing loans ratio should higher after 2008 global financial crisis in Chinese commercial banks Thus we expected a positive relationship between the global financial crisis and the bank's credit risk.

Hypothesis 11: 2008 Financial Crisis will has a positive relationship between the Chinese commercial bank's credit risk

Table 4.1 Summary of Variables

Variable	Abbreviation	Measurement	Expected Sign
Dependent Variable			
Credit Risk	NPL	Non-Performing Loans (NPL) Ratio	
Independent variables - Macroeconomic			
GDP Growth	GDPr	Real GDP Growth Rate (%)	+
Inflation	INF	Consumer Prices annual (%)	+
Interest Rate	INR	Lending Interest Rate	+
Exchange Rate	EXR	Direct Quotation for US dollars	
Unemployment	UNR	Unemployment Rate	+
Independent variables - Microeconomic			
Bank Size	SIZE	Natural Logarithm of Total Assets	–
Regulatory Capital	CAR	Total Regulatory Capital Ratio	–
Bank Efficiency	BKEF	Return On Average Total Assets	+
Loan Loss Provision	LLP	Loan Loss Provision to Total Loans Ratio	+
Dummy Variables			
State-Owned Commercial banks	OWN	1 if state-owned banks, 0 otherwise	+
2008 Global Financial Crisis	GFC08	1 if observations after 2008, 0 if observations before or	+

during 2008

Econometric Model

For the purpose of formalize the applicable hypotheses, the above mentioned variables need to be summarized into an econometric model. Therefore, the equation of the model to be used in this research can be summarized as follows:

$$NPL_{it} = \beta_0 + \beta_1 GDPr_t + \beta_2 INF_t + \beta_3 INR_t + \beta_4 EXR_t + \beta_5 UNR_t + \beta_6 SIZE_{i,t} + \beta_7 CAR_{i,t} + \beta_8 BKEF_{i,t} + \beta_9 LLP_{i,t} + \beta_{10} OWN_{i,t} + \beta_{11} GFC08_{i,t} + \varepsilon_{i,t}$$

4.5 Data

To explore the determinants of credit risk empirical analysis in Chinese commercial banks, the data based on income statement and balance sheets of Chinese commercial banks is gathered from the Fitch IBCA/Bureau van Dijk's BankScope database. The ownership information obtained from the China Banking Regulatory Commission, the macroeconomic data are obtained from China Almanac of Finance. All the data are collected from year 2003 to 2013. However, due to some banks do not provide the full information for each variable. A selection criterion is adopted in this research. The final dataset is based on the following criteria: First, the banks with less than three consecutive years of observations have been deleted. Second, the observations with missing some values have been excluded from the dataset. The original dataset includes 200 active bank institutions from BankScope, however, the Chinese banking sector are heterogeneous across different groups, e.g. these institutions are subject to different regulations then the changes might cause instability in coefficient between different groups. In order to obtain more homogeneous group of banks, only commercial banks are considered in this research, The final dataset, which is a

unbalanced panel data, end up with a smaller sample, 64 commercial banks with 342 bank-year observations are selected for this research.

4.5.1 Descriptive Statistics

Table 4.2 shows the descriptive statistics (mean, standard deviation, minimum and maximum values, No. of observations) for the dependent variable and explanatory variables. For the unexpected loss, under the Basel Accords, banks need set up capital at least equal to 8% of risk-weighted assets to cover the unexpected losses. For the total capital ratio, the average value for all banks is 12.88 percent, which is higher than the Basel I and II regulatory capital requirement, but the lowest value is 1.45 percent which is much lower than the minimum 8% value, banks with an insufficient regulatory capital may cannot fulfill their obligation and finally have a bankruptcy risk. Furthermore, with an average value equal to 10.04 % of the real GDP growth rate and a Minimum value equal to 7.8%, it indicates that the Chinese economy has a sustainable economic growth in the past 10 years.

Table 4.2 Descriptive statistics for the variables

Variable	Mean	Std. Dev.	Minimum	Maximum	Observations
NPL	1.972602	1.954409	0.01	13.14	342
GDPr	10.04064	1.7211	7.8	14.2	342
INF	3.162846	2.150137	-0.7029492	5.864384	342
INR	5.955497	0.6260303	5.31	7.47	342
EXR	6.947136	0.5868098	6.3125	8.277	342
UNR	4.144737	0.0870758	4	4.3	342
SIZE	18.79261	2.053174	15.15545	23.58788	342
CAR	12.87614	5.275146	1.45	54.62	342

BKEF	1.001959	0.4721281	-0.48	3	342
LLP	0.0245403	0.2077733	.0000397	3.224242	342
OWN	0.122807	0.3286965	0	1	342
GFC08	0.6520468	0.477019	0	1	342

Table A-1 (See Appendix) describes the correlation matrix of the variables. If some or all of the explanatory variables are highly correlated with one another, a possible multicollinearity problem will be emerged. If there has a multicollinearity problem, the regression model will has difficulty to determine which of the explanatory variable(s) is influencing the dependent variable. The table above indicates the overall correlations between the variables are not strong except the correlation between LR and UNR with a -0.8334, but the correlation with other variables is weak. However, a formal test, the variance-inflation Factor (VIF) test, to detect the multicollinearity among variables will be conducted in the following data analysis process.

As NPL ratio can be used as a proxy for bank's credit risk, the fluctuation of the NPL ratio reveals the movement of bank credit risk. **Figure 4.1** describes the Non-performing loans changes in Chinese banking sector from 2003 to 2012. It can be clearly seen from the chart that the Non-performing loans in the state-owned banks account for the most of total non-performing loans of whole banking sector in China. Furthermore, **Figure 4.2** demonstrates a downward trend for the Non-Performing loans ratio in Chinese banking industry, there is a downward trend for the NPL ratios for all three types NPL ratio from 2003 to 2012, the NPL ratio for both State-owned banks and the whole banking sector have a slightly rise between 2006 to 2007 while the other banks' NPL ratio had a slightly decrease. The differences between NPL ratio in other commercial banks and Total NPL ratios is while there is not an obvious difference between the total NPL ratio and the ratio of State-owned commercial banks. The graph indicates that the trend of total commercial bank NPL ratio is consistent

with the state-owned commercial banks NPL ratio. It can be concluded that state-owned banks have a decisive impact on the NPLs performance in Chinese commercial bank market than other banks.

Figure 4.1 Non-Performing Loans For Chinese Banking Industry from 2003-2012

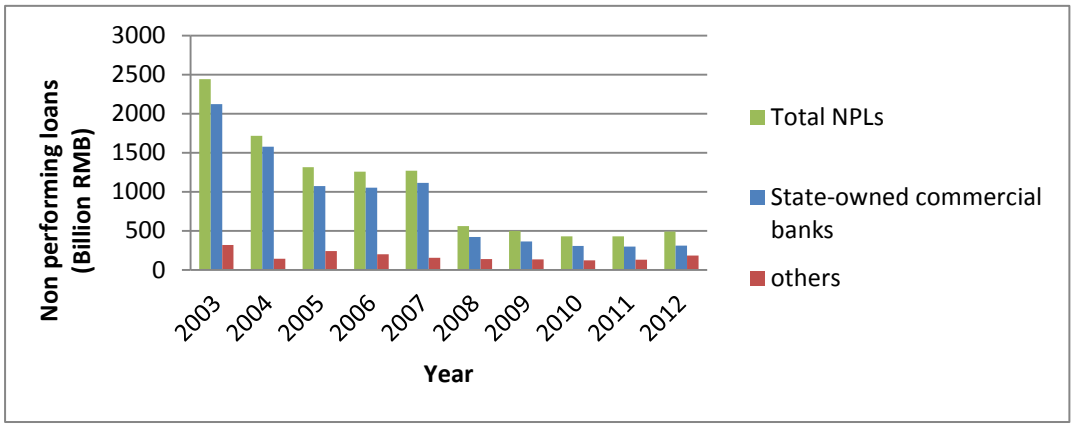
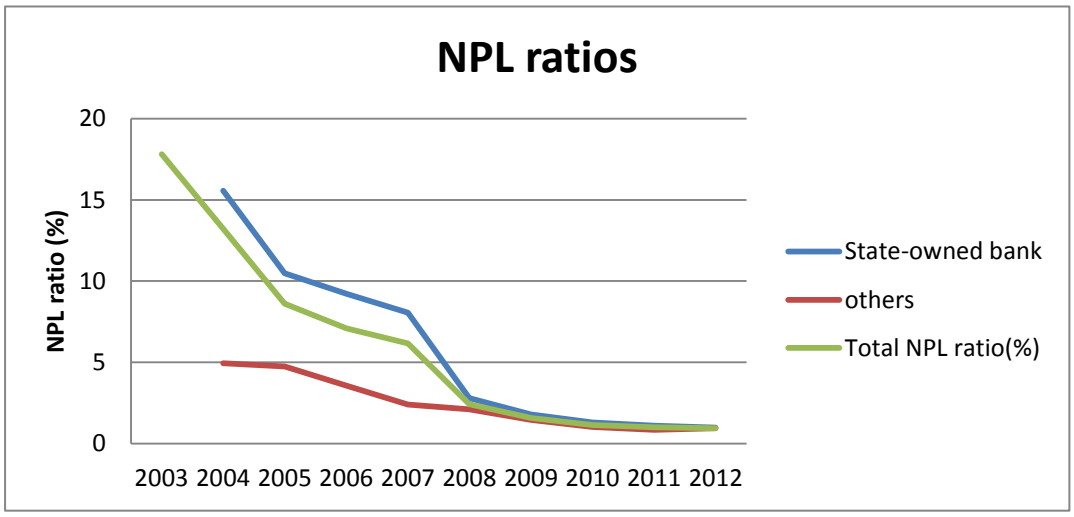


Figure 4.2 Non-Performing Loans Ratios for Chinese Banking Industry from 2003 to 2012



Chapter 5: Empirical Results and Discussion

This chapter will demonstrate the relationship among each explanatory variable to the credit risk, which is measured by the Non-performing loans ratio, for Chinese commercial banks from 2003 to 2012. This part will analyze the results obtained from the regression models.

Hypotheses 1-9 – Credit risk (NPL) and the Independent variables

As the hypotheses mentioned in the **Table 4.1**, the analysis in this section will focus on impact of the macroeconomic factors and microeconomic factors on Chinese banks credit risk, thus a model for those variables can be written as:

$$NPL_{it} = \beta_0 + \beta_1 GDPr_t + \beta_2 INF_t + \beta_3 INR_t + \beta_4 EXR_t + \beta_5 UNR_t + \beta_6 SIZE_{i,t} + \beta_7 CAR_{i,t} + \beta_8 BKEF_{i,t} + \beta_9 LLP_{i,t} + \varepsilon_{i,t} \quad \text{(Model 1)}$$

After establishing the basis model for testing the hypothesis, inspect the existence of Multicolinearity and heteroskedasticity is an important step for analysis the research dataset. Even a simple Ordinary Least Square (OLS) regression for model 1 with F-statistics (0.0000), which is an indicator of overall adequacy of the estimated model through testing the joint significance of the parameters, is significant less than 5%. it is more formal to use the Variance Inflation Factor (VIF) test to determine whether there has a multicolinearity problem. As mentioned in previous chapter, the value of 10 is used as a threshold as rule of thumb for VIF statistic. VIF results are shown in the **Table 5.1**, the VIF is significantly lower than the critical value thus provides the evidence against multicolinearity problem.

Table 5.1 VIF values for Model 1

Independent Variables	**VIF**
GDPr	5.04
UNR	4.29
INR	4.08
UNR	4.29
EXR	4.01
INF	1.61
BKEF	1.26
CAR	1.17
SIZE	1.07
LLP	1.06
Mean VIF	**2.62**

After checking for the Multicolinearity problem, to test the assumption of the disturbance term has constant variance for Classical Linear Regression model, the White's General Test is used to detect the presence of heteroskedasticity. Since the statistic value is larger and with is lower than 5% significance level (p=0.0150), thus

the null hypothesis of homoskedasticity can be rejected for model 1 and provide evidence for there might exist a heteroskedasticity problem. Afterwards, the Breusch and Pagan test, which is used to test the existence of individual heterogeneity is conducted, a robust evidence for the inappropriate for the OLS regression is provided as the null hypothesis of there is no heterogeneity is rejected. Due to the existence of heteroskedasticity and individual heterogeneity problem, a straightforward OLS regression becomes inappropriate for this model

As suggested in the Chapter III, as using OLS is not feasible thus a GLS method for using either Random Effects or Fixed Effects model will be taken into account. To determine which model is more suitable, a Hausman test is conducted. As the P-value (0.3541) is higher than the 5% significance level, thus the null hypothesis "regressors and effects (heterogeneity) are not correlated" cannot rejected, thus a random effects model is used in this section.

Before analyze the results from model 1, there is an important element that need to be considered, which is the R-squared value. R-square statistics gives information about the goodness of fit of the model. R-square statistics with value of 0.4355 suggests that 43.55% of the variability in NPL ratios can be explained by the independent variables in model 1.

Table 5.2 Random Effects Results for Model 1

Determinants	Coefficient	Standard Error	Nature of Correlation With NPL ratio
GDPr	-0.1327511	0.08683	Negative
INR	-0.4779932**	0.2100018	Negative
INF	0.0850776**	0.038538	Positive
EXR	-1.84008***	0.2529379	Negative
UNR	-3.991447***	1.549784	Negative
SIZE	-0.1123677*	0.0665471	Negative
CAR	-0.0830715***	0.0192086	Negative
BKEF	-0.8082228***	0.2015029	Negative
LLP	1.138896***	0.403348	Positive
R-Square	**0.4355**		

Notes: The regression is estimated using the random effects model over a sample of 64 banks from the year 2003 to 2012. ***, ** and * indicate parameter significance at 1%, 5% and 10% significance level respectively.

According to the results from table 5.2, the coefficient could be explained as follows:

The estimated coefficient for real GDP growth rate is negatively but not significant related to the bank's non-performing loans ratio, the coefficient is -0.1327511. Therefore it suggests that there is no direct relationship between the real GDP growth rate and bank's credit risk in Chinese commercial banks. Results is consistent with the previous studies from Kalirai and Scheicher (2002), Fofack (2005) and Aver (2008) that there is no relationship between the GDP and credit risk. The sign indicates that during the economic booming period, the economic activities are increase thus both

the borrowers and banks will hold sufficient cash so that with enhanced repayment ability. On the other hand, during the recession period, the repayment ability will worse than before, thus increase the loan default probability. However, the insignificant coefficient between the real GDP growth rate and NPLs ratio in Chinese commercial banking industry can be explained by as the Chinese economy has a sustainable economic growth, the fluctuation of the real GDP growth may has a insignificant affects on the levels of nonperforming loans in Chinese commercial banks. The limited sample data in our research, even our sample data are from year 2003 to 2013, due to the selection criteria, banks with less than three consecutive years will be deleted, thus the time period is not with a enough time span. Furthermore, as the Chinese economic is constant growing from the year 2003 to 2012, thus during the economic booms period, the real GDP growth rate may not have a significant impacts on the bank's non-performing loans.

Depend on the previous studies mentioned in the Chapter II, as inflation will depreciates the value of money thus reduce the return of the bank, banks will try to anticipate the future inflation then adjust the interest rate in order to compensate such losses. Normally, a high inflation will lead to a high interest rate, then it will increase the obligation of the loan borrowers, an increased debt burden will finally caused an increase in default probability. The result is consistent with Gunsel (2008), Zribi and Boujelbene (2011), the inflation which is measured by Consumer Price (Annual %) has a significant positive relationship (at 5% confidence level) with the NPLs ratio, and it indicates that a unit increase in the growth of consumer prices will lead to 0.0850776 increases in the NPLs ratio, all other variables remaining constant. When government faces the inflation problem, a tight monetary policy will be used to keep inflation get worse. As tight monetary policies always increasing the interest rate to reduce the inflation effects, then tight monetary policies can reduce the amount of credit, because banks cannot generate enough income from the interest rates on loans. For the companies, a rising price for goods and services also need more cash to maintain production. As a result, those borrowers highly rely on loans prefer to

choose default.

The relationship between the lending interest rate (INR) and credit risk (NPL) can be shown from table has a significant negative relationship (at 5% significance level). This result is not consistent with the previous studies conducted by Richard (1999), Kalirai and Scheicher (2002) and Fofack (2005) as their researches suggest there exist a positive relationship between the interest rate and bank's credit risk. It can be explained that when the interest rate is high, the adverse selection problem will be emerged. As mentioned in the theory of adverse selection, even the interest rate is high, some borrowers still conscious it is attractive for them to borrower the loans with their poor credit quality. Thus banks will pay more attention to such activities, conduct a more prudent credit appraisal and monitoring to reduce the adverse effects from the lower credit quality borrowers, and thus reduce the non-performing loans.

The explanatory variable of Exchange rate (EXR), which is measured by direct quote for U.S dollar are used in this research. E.g. a direct quote for U.S dollar would be 6.12 Yuan equal to 1 U.S dollar, thus an increase in exchange rate indicates a depreciation of local currency. In this model has a significantly negative relationship between the bank's credit risks (NPLs ratio) at 1% significance level. The coefficient equals to -1.84008 indicates that one unit increase in the value of local currency to foreign currency will lead to 1.84008 units decrease in bank's credit risk (NPLs ratio). The results is consistent with Gunsel (2008), Zribi and Boujelbene (2011) and Castro (2013). The results suggest that as the depreciation of local currency will, make the domestic industry more expensive to acquire foreign goods and services, finally it will affects the price of the local products. Therefore, a higher production cost lead to an uncompetitive price lead the domestic firms have difficulty to retain the local customers. Higher cost will weaken the competitiveness of export-oriented and affects their ability to service their debt adversely. The consequence for this is the increasing demand for bank credit to support the additional expenditure caused by the depreciation of local currency. In Chinese markets, since china joined WTO in year

2001, world trade businesses are more frequently than before, as mentioned in the Chapter II, the export of goods and services are now account 33.53% of GDP on average in china, thus the export-oriented companies are more vulnerable to the fluctuation of foreign exchange fluctuation. As a result, the hypothesis that fluctuation of exchange rate is negatively related with bank's credit risk is accepted.

The regression result of UNR shows the coefficient estimate is significantly negative related with the bank's credit risk (NPL) in the estimation model at 1% significance level. This result suggests that unemployment rate has substantial impacts on credit risk. However, the sign of coefficient is not consistent with what it was expected. The result can be explained that as the increase on unemployment rate, the cash flow of household will decrease, banks tend be more cautious for the loan appraisal and management. Furthermore, due to the limited data, the results cannot be representativeness of the relationship between the unemployment rate and bank's credit risk in China.

The estimated coefficient of bank size (SIZE), measured by the logarithm of total assets, is negatively related to bank credit risk (NPL), with the value of coefficient of -0.1123677, the value is statistically significant at 10% confidence level. The negative relationship between SIZE and NPL indicates that as the bank size increases, bank's credit risk is reduced through lowering the NPLs ratio. This result is consistent with Salas and Saurina (2002) Rajan and Dhal (2003), Hu et al. (2004). The results suggest that banks with different size and diversified portfolios have a significant impact on the loan quality. According to the diversification theory and Diamond (1996), since larger banks normally have larger amounts of borrowers with variety kind of businesses, a diversified loan portfolio can lower the unsystematic risk. Furthermore, due to large banks may involve in variety of business operations rather than those mainly rely on the interest income and more experienced in risk management, thus through a effective monitoring and appraisal of the credit, larger banks can have more ability to control for the credit risk than the smaller banks. Thus the hypothesis that

the Banks Size and credit risk is negatively correlated is accepted.

As is shown in the table 5.2, the coefficient obtained for the explanatory variable regulatory capital (CAR), which is measured by Total Regulatory Capital to Risk Weighted Assets ratio, is negatively related with bank credit risk (NPL) at 1% significance level. Holding all other things constant, a unit increase in total regulatory capital ratio will result in a 0.8082228 decrease in the proportion of non-performing loans to total loans. As the previous studies indicated, low regulatory capital ratio corresponds to thinly capitalized banks are more prone to risk. On the other hand, banks with higher reported capital ratio are better qualified in absorbing losses. The result is consistent with Shrieves and Dahl (1992) and Berger and DeYoung (1997), According to the Basel Accords I and II, banks have to hold a minimum 8% capital (tier 1 capital plus tier 2 capital) to absorb unexpected losses. As a result, a higher total regulatory capital will provide more cushions for absorbing losses and then reduce bank problem loans and credit risks.

It can be seen from the **Table 5.2** that the relationship between the efficiency ratio and bank credit risk is statistically significant negative at 1% significance level. Management Efficiency (BKEF), explained by return on average total assets, with a coefficient value -0.8082228 indicates that efficiency of a bank's management will lead to a lower credit risk. The result is consistent with what is was expected in the Chapter III, which is the higher the efficiency the lower in credit risk and alternatively lower efficiency depict higher credit risk. the result is support the previous studies from Berger and DeYoung (1997) and Podpiera and Weil (2008), "bad management" indicates that inefficiency will positively related with the future non-performing loans, thus a higher efficient management implies a good skills in the credit rating, appraisal of collateral and monitoring of loans. Thus the hypothesis that bank efficiency is negatively related with the bank credit risk is accepted in this model.

The sign of the coefficient of loan loss provision, which is measured by loan loss

provision to total loans ratio, is statistically significant related with the bank credit risk (NPL) at 1% significance level. The coefficient value 1.138896 indicates that banks with higher rate of problem loans (NPL) exhibit lower level of provision rates. The result is similar to Ahmed et al. (1998), Gueyie and Ortiz (2002) and Bikker and metzemakers (2004), they found the Loan Loss provision is positively related to credit risk. Normally, banks anticipate the levels of potential capital losses thus create loan provisions to decrease earning volatility. The Loan provision is based on certain credit risk considerations, which are default risk, risk tolerance, and the macroeconomic environment (Floro, 2010). Loans can be classified into two groups, the specific and general provisions. The former is for absorb the losses in an individually loan while the other one is made for a loan portfolio.(Borio and Lowe, 2001) Therefore, if the banks expect a high level of default probability of loans and deterioration in loan quality, more loan loss provisions will be reserved. Thus the hypothesis that loan loss provision and credit risk is positively related is accepted.

Hypothesis 10 - Credit risk and bank's ownership

This part investigates the hypothesis that if there exist differences in credit risk between the state-owned commercial banks and other type's banks in Chinese commercial banks. The following econometric model is employed to get quantification relationship between

$$NPL_{it} = \beta_0 + \beta_1 GDPr_t + \beta_2 INF_t + \beta_3 INR_t + \beta_4 EXR_t + \beta_5 UNR_t + \beta_6 SIZE_{i,t} + \beta_7 CAR_{i,t} + \beta_8 BKEF_{i,t} + \beta_9 LLP_{i,t} + \beta_{10} OWN_{i,t} + \varepsilon_{i,t} \quad \text{(Model 2)}$$

The dummy variable GFC is not including in model 1. Since a new variable is added into the econometric model, the multicolinearity and heteroskedasticity are tested again to confirm the relevancy and fitness of the econometric model. As the existence of heteroskedasticity will biased the OLS regression, VIF test is conducted and the

test statistics are shown as **Table 5.3**.

Table 5.3 VIF values for Model 2

Independent Variables	VIF
GDPr	5.04
INF	1.62
INR	4.08
EXR	4.17
UNR	4.30
SIZE	2.17
CAR	1.21
BKEF	1.27
LLP	1.06
OWN	2.14
Mean VIF	**2.71**

Similar to the econometric tests conducted in the model 1, the values of VIF is under 10 thus it can be conclude there is no multicolinearity problem. Furthermore, through conducting the White's General Test to detect heteroskedasticity problem, the P value (P=0.0132) is lower than the 5% significance level indicates we can reject the null hypothesis of homoskedasticity. Finally, Breusch and Pagan test is conducted to test the existence of individual heterogeneity for across different banks, the result with P-value equal to zero indicates there is individual heterogeneity in the panel data.

The Hausman test statistic value, Prob>chi square equal to 0.085, indicates there is has a correlation between the explanatory variables and the error term, thus providing a sufficient justification to use the results from the Random Effects regression.

Table 5.4 Random Effects Results for Model 2

Determinants	Coefficient	Standard Error	Nature of Correlation With NPL ratio
GDPr	-0.1343991	0.0870706	Negative
INR	-0.4775727**	0.2107897	Negative
INF	0.0782006**	0.0387887	Positive
EXR	-1.690927***	0.2593421	Negative
UNR	-4.295265***	1.560866	Negative
SIZE	-0.2412012***	0.0858168	Negative
CAR	-0.089024***	0.0190152	Negative
BKEF	-0.855666***	0.1996636	Negative
LLP	1.099473***	0.3994716	Positive
OWN	1.314708**	0.5850396	Positive
R-Square	0.4613		

Notes: ** and * indicate parameter significance at 5% and 10% significance level respectively.

Compared the results with model 1, it is found a similar results with some minor variation in their coefficient values. Furthermore, the model 2 employed for the hypotheses is also extremely significant with a p-value of 0.0000, moreover, the R-square value of 0.4613 indicate that all the variables in the econometric model 2 can explain 46.13 percent of determinants for Bank credit risk (NPL). Most of the significant determinants are reacting in a similar fashion as they did with the model 1.

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can explain 46.13 percent of determinants for Bank credit risk (NPL). Most of the significant determinants are reacting in a similar fashion as they did with the model 1.

The dummy variable, OWN, controlling for state-owned banks and other types commercial banks (includes City commercial banks, joint-stock commercial banks, and foreign commercial banks) in Chinese banking sector has a coefficient value of 1.314708 observing a positive correlation. This result indicates that the state-owned Chinese banks are likely to have a higher credit risk. The outcome is founded to be statistically significant with P>|z| value is 0.025 at 95% confidence level. Therefore, the null hypothesis of there has no differences between state-owned commercial banks with other types' commercial banks cannot be accepted.

There are a number of studies addressing the issue of similarities and difference in credit risk among different ownership structure. Even though some of the studies do not seem to relate the credit risk directly, but we can still find some factors to explain the differences between those different bank groups. As Iannota, Giacomo and Sironi (2007) found that public sector banks had poorer loan quality and higher insolvency risk than other types of banks while mutual banks had better loan quality and lower asset risk than both private and public sector banks, so we can expect that banks in different types have different level of credit risk, and the public banks like state-owned banks may have more credit risk than others. As the previously studies conducted by De Nicolo (2001) and Micco (2004), these studies indicate that state ownership is positively related with the bank's non-performing loans and insolvency risk. As our result is consistent with those studies, thus we can conclude that in Chinese banking industry, state owned banks take on more credit risks than other banks. Sapienza (2004) indicated three different views to explain the reasons for state-owned banks exhibit more risky than others, "social view" indicates that the state-owned banks have a duty to correct the market failure brought by private banks. From the "political view", the state-owned banks can be used to pursuing politician's private interests, thus the government intervention would lead state-owned banks to

consider more political factors rather than economic ones, e.g. most of loans from state-owned banks flowed to State-owned enterprises (SOEs), and often became non-performing loans(Firth et al., 2009). According to the agency view, state-owned banks are benevolent maximizers but they are plagued by corruption and misallocation.

Furthermore, the result is obtained through compare the state-owned to other three main types (joint-stock, city and foreign commercial banks) bank. As different ownership structures mean different corporate governance mechanisms and behavior choices, which affect bank credit risk as well. From the perspective of agency theory, considered that state-owned were less monitored by their owners and had worse corporate governance compared with other ownership structure banks, which will makes the state-owned banks were more likely to be less prudent, this will affect the risk management process in state-owned banks, especially in the credit appraisal and monitoring. According to the moral hazard theory, the state-owned banks are more likely to be bailed out by the government, this will lead the managers in state-owned banks put less effort than other ownership structure banks or divert resources for personal benefits.

According to the above analysis, the hypothesis of State-owned banks will take on more risks than other type's commercial bank in China is accepted.

Hypothesis 3- 2008 Global Financial Crisis

Similar to the previously tested hypotheses, as the 2008 global financial crisis caused the world's financial system by surprise, it is expected that the dummy variable GFC08 will provide additional valuable insights of impacts from the financial crisis which initiated in 2008 on Chinese commercial banks. Therefore, to establish empirically results of the impact of the crisis on credit risk in Chinese commercial banks, the following econometric model is expected to provide a conclusive

demonstration:

$$NPL_{it} = \beta_0 + \beta_1 GDPr_t + \beta_2 INF_t + \beta_3 INR_t + \beta_4 EXR_t + \beta_5 UNR_t + \beta_6 SIZE_{i,t} + \beta_7 CAR_{i,t} + \beta_8 BKEF_{i,t} + \beta_9 LLP_{i,t} + \beta_{10} OWN_{i,t} + \beta_{11} GFC08_{i,t} + \varepsilon_{i,t} \quad (Model\ 3)$$

The model utilized for this hypothesis includes all the variables as mentioned in the Chapter III. Compared to the econometric models employed in the previous hypothesis testing, dummy variable GFC08 is included in Model 3. Due to the number of variables is increased, it is necessary to detect the multicolinearity problem. The result of VIF test is shown in the **Table 5.5**, values of all variables lower than 10 indicates there is no multicolinearity problem in this model.

Table 5.5 VIF values for Model 3

Independent Variables	**VIF**
GDPr	5.06
INF	3.07
INR	4.13
EXR	8.03
UNR	4.41
SIZE	2.18
CAR	1.21
BKEF	1.28
LLP	1.06
OWN	2.14
GFC07	5.71
Mean VIF	**3.48**

Breusch-Pagan and Hausman test also produce Prob>Chi-square is 0.0000 and 0.9987

respectively, ascertaining the applicability of a Random Effects regression. The results generated from the RE regression in order to interpret the findings is shown in the **Table 5.6.**

Table 5.6 Random Effects Results for Model 3

Determinants	**Coefficient**	**Standard Error**	**Nature of Correlation With NPL ratio**
GDPr	-0.134815	0.0871504	Negative
INR	-0.4755974**	0.2118908	Negative
INF	0.07481	0.0532069	Positive
EXR	-1.672135***	0.3413195	Negative
UNR	-4.315814***	1.578611	Negative
SIZE	-0.2406186***	0.0865784	Negative
CAR	-0.088933***	0.0191249	Negative
BKEF	-0.8537638***	0.2003648	Negative
LLP	1.098684***	0.4015753	Positive
OWN	1.312445**	0.5897239	Positive
GFC08	-0.0311241	0.3305272	Negative
R-Square	0.4612		

Notes: ** and * indicate parameter significance at 5% and 10% significance level respectively.

The model 3 includes the dummy variable GFC08 does not significantly impact the results for the credit risk determinants. As shown in the previous two tests, the results are similar in terms of the independent variables and the dummy variables as the nature of their relationship between with the Credit risk, although some slightly changes in values of the respective αand β coefficients and the Inflation (INF) in

model 3 become insignificant, the overall impact remains the same.

To check the robust outcomes for Hypothesis 11, model 3 provide highly significant results with a p-value of 0.0000. Inclusion of the GFC08 to establish the relationship between the NPL aims to provide empirical explanation of the impact of 2008 financial crisis on Chinese commercial banks, the dataset generate a R-squared value of 0.4612 indicates that by including all the variables identified in the Chapter III, the model can explain 46.12 percent of the factors affect the Chinese commercial banks. GFC08 with a coefficient of 0.0311241 observing a negative correlation indicates that after year 2008. However, the result with P>|z| of 0.925 indicates the results is statistically insignificant. The hypothesis of 2008 global financial crisis has positive impact on the bank's credit risk is not accepted.

As the result shows there has a statistically insignificant relationship between the financial crisis of 2008 and the Chinese commercial banks. That means the 2008 global financial crisis has no impact on the Chinese commercial bank's credit risk. However, the result coefficient is insignificant and do not consistent with what it was expected (positive). According to Morrison (2009), the degree of exposure of Chinese banking industry to the 2008 financial crisis is ambiguous in some way due to Chinese banking industry is do not fully embrace financial liberalization and relatively isolated from the world market. Furthermore, to response the financial crisis and simulating the demands, Chinese government announced a two-year 4-trillion RMB (586 billion dollar) package which can be account for 13.3 % of the GDP in year 2008 (Zhang, 2010; Morrision, 2009). Moreover, the government decided to adopt active fiscal policy and a relative loose monetary policy, reduce the interest rate to relax the restrictions on loans thus maintain the economy growth. As a result, the real GDP growth rate did not reduce too much (0.4%) and then back to 10.3% in 2010.

On the other hand, a large amount of money poured into the markets can cause the

inflation problem and economic bubble, especially in the real estate market (Wang, 2010), and finally cause the non-performing loans increase in future. A loose money supply can cause the excess of production of capacity problem, the policy encourage some industry to hoard raw materials for appreciation and investing in low efficiency but high energy consumption projects, even they can contribute the economic boom in a short term, but such concentrated and unscientific lending would increase the probability of default in a long run. Furthermore, under the 4 trillion simulates program, a financing platform have been set up by local government. The local government turned lending funds into project capital of subsidiary companies thus the financial leverage of bank lending become much larger. As some projects were launched rashly during the crisis without a prudent analysis and test the repayment capacity, and a large proportion of projects have mortgage the land which is quite uncertainty in generating the future profit. These all can be a danger of increase the bank's credit risk.

However, due to the complexity of Chinese economy and the empirical result, the hypothesis of global financial crisis is positive related to the Chinese commercial banks credit risk can be rejected.

Chapter 6: Conclusion

6.1 Introduction

Even Chinese banking industry has implemented a series reforms in the last three decades, the banking system is still far from a developed and efficient system. In order to measure the credit risk more accurately in Chinese unique national conditions, an empirical study is carried out to investigate the determinants of credit risk and the impacts of 2008 global financial crisis in Chinese commercial banks. Based on the previous studies on the credit risk determinants, macro-economic factors and bank-specific characteristics are used as the explanatory variables of the bank's credit

risk. Furthermore, two dummy variables are used for distinguish the impacts of bank's ownership structure and the year period before and after the global financial crisis on Chinese commercial banks' credit risk. The analysis was based on a quantitative approach with a panel dataset consists of 64 Chinese commercial banks from the year 2003 to 2012. Three econometric models are used in this research. Based on the several fairly robust checks, random effects model are adopted in those three models.

6.1 Findings

The obtained result indicates that the real GDP growth rate has a negative but not significant impact on the Chinese commercial bank's credit risk. The result is not consistent with most of previous studies, however, the result is similar to Fofack (2005), which indicate there is no any relationship between GDP and credit risk. Such result can be explained by during the economic boom period, the repayment ability will be increase and then lower the loan default rate, while on the recession period, the default rate will increase due to the sufficient cash hold as a result of lower economic activities.

The relationship between the inflation and credit in this study which is positive related, it can be explained that a high inflation will lead banks increase the interest rate to compensate the losses by the depreciation of money. A higher interest rate will also increase the debt burden for the borrowers, thus, increase the bank's credit risk.

In this study, the result shows the interest rate has a significant negative impact on the bank's credit risk, however, this result is not consistent with what it was expected, the explanation for such a result can be the banks take a more prudent credit appraisal and monitor process to avoid the lower quality borrower, therefore reduce the effects of higher default probability caused by high debt burden.

The results for exchange rate and unemployment are both exhibit a significantly negative relationship between the bank's credit risks. As the exchange goes up, in other words, a depreciation of the local currency to the foreign currency will lead the bank's credit risk increase, in this study, the Direct Quotation are used, as the export account for almost 33.53 percent of china's GDP, the export-oriented companies are vulnerable to the exchange rate fluctuations, an appreciation of foreign currencies will increase the cost of imported inputs for the domestic industry thus increase the cost of production, a lower profitability affect their ability to service the loans thus finally increase the default probability of the companies. The negative relationship between the unemployment rate and is not consistent what it was expected in the hypothesis. However, the result can be explained by the bank take more cautions on the credit lending to reduce the increased default rate brought by the higher debt burden.

For the bank characteristic determinants, the empirical results from this study are all consistent with the hypotheses were assumed in chapter III. Evidence suggest the Chinese commercial banks' credit risk is negatively related with the bank size, as the larger banks with a diversified loan portfolio and variety of different borrowers then it can reduce the systematic risks. Moreover, due to the larger banks may involve in variety of businesses rather than those smaller banks which is mainly focus on the interest income, thus have more ability to control for the credit risk than the smaller ones. The relationship between the regulatory capital ratio and bank's credit risk also signify a higher regulatory capital ratio will lead to Chinese commercial banks suffer a lower credit risk. This can be explained by a higher regulatory capital ratio will provide more cushion for the unexpected losses thus reduce the bank's credit risk. The results also indicate the relationship between the bank management efficiency is statistically negative related to the credit risk of Chinese commercial banks. As the bad management hypothesis suggests that inefficiency of management implies a bad skills in the rating the credit, collateral appraisal and loans monitoring, finally lead to a higher level of credit risk.

The result obtained from this study indicates that different ownership structure will affect the bank's credit risk significantly in Chinese commercial banks. The state-owned banks will bear more credit risks than other type's commercial banks. According to Sapienza (2004), it can be concluded into three main reasons, the political view indicates that the state-owned banks can be used to pursue the politician's private interest, thus such a intervention will lead state-owned banks consider more political factors rather than economic ones. The social view describes that state-owned banks have a duty to correct the market failure brought by private banks. "Agency view" states that state-owned banks are plagued by corruption and resource misallocation, thus lead to an ineffective management. Therefore, the state-owned banks will bear more risks than others. Furthermore, according to the Jia (2009) considered that state-owned were less monitored by their owners and has a worse corporate governance, it will lead the state-owned banks were likely to be less prudent, thus affect the credit appraisal and monitoring. Moral hazard problem can also lead the state-owned banks to take on less efforts on the credit risk management, cause they firmly believe they will be bailed out by the government.

As the result indicated, 2008 global financial crisis has a no significant effects on the bank's credit risk on this study. The result can be explained by two reasons. After the 2008 global financial crisis broke out, as the Chinese banking system is still isolated from the world markets with inexhaustive embrace financial liberalization, the global financial crisis has limited effects on the Chinese banking industry. Moreover, Chinese government is take efforts to simulate the Chinese economy with a 4-trillion investment in domestic market and a proactive monetary policy was carried out to maintain the overall economy growth, thus keep the economic activity. On other hand, as the large amount of money poured into the markets it will cause the inflation and economic bubble (Wang, 2010), thus finally lead to non-performing loans increase in the future. Moreover, as the local government set up the financing platform to lend funds to into funds into project subsidiary companies under the 4 trillion package, the financial leverage of bank lending become much larger, due to some projects without

a prudent analysis and mortgage the land with uncertainties in generate future profit, lead to a increasing in bank's credit risk in Chinese commercial banks.

6.3 Limitations and recommendations for future research

As this study is an empirical analysis with quantitative method to investigate the determinants of Chinese commercial banks credit risk, it is subject to limitations related to the number of the observations in the data sample, as mentioned in the previous chapters, due to the opaque banking system in Chinese banking industry, the data obtained from the BankScope is limited in numbers, and the bank with less than three consecutive years of observations and missing values are excluded from the dataset, the final dataset includes 64 commercial banks is a relative small sample size in the research. As the Chinese banking system are become more and more transparent, therefore the future research based on a large sample with a wide time frame to provide more comprehensive study of the credit risk determinants in Chinese banking industry. Furthermore, due to current level of non-performing loans may depend on its past level, a dynamic model can be used to get a more conclusive results for the determinants of credit risk in Chinese commercial banks.

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Appendix

Appendix-1

Table A-1. The correlation matrix of the variables

	NPL	GDPr	INF	INR	EXR	UNR	SIZE	CAR	BKEF	LLP	OWN	GFC08
NPL	1.0000											
GDPr	0.4093	1.0000										
INF	-0.0001	0.1312	1.0000									
INR	0.0168	0.5200	0.4542	1.0000								
EXR	-0.5598	-0.7383	0.1432	-0.0357	1.0000							
UNR	-0.0094	-0.4047	-0.5955	-0.8334	-0.0707	1.0000						
SIZE	-0.1037	-0.0840	-0.0072	0.0219	0.0426	-0.0309	1.0000					
CAR	-0.3029	-0.2097	0.0848	-0.0404	0.2627	-0.0217	-0.1651	1.0000				
BKEF	-0.4155	-0.2713	0.1373	0.0202	0.3963	-0.0870	0.0706	-0.0354	1.0000			
LLP	0.1844	0.1029	0.0662	0.0749	-0.0517	-0.0522	-0.0778	-0.1104	-0.1307	1.0000		
OWN	0.1181	0.0668	-0.0168	-0.0163	-0.1712	0.0329	0.6845	-0.0574	0.0228	-0.0332	1.0000	
GFC08	-0.4925	-0.6335	-0.2717	-0.0835	0.8022	0.0511	0.0821	0.2090	0.2744	-0.1016	-0.1194	1.0000

Appendix 2- STATA Outputs

Appendix 2.1 – Results for Model 1

```
. xtreg NPL GDPr INF INR EXR UNR SIZE CAR BKEF LLP, re

Random-effects GLS regression                   Number of obs      =       342
Group variable: bank                            Number of groups   =        64

R-sq:  within  = 0.5314                         Obs per group: min =         3
       between = 0.2941                                        avg =       5.3
       overall = 0.4355                                        max =        10

                                                Wald chi2(9)       =    330.68
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         NPL |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        GDPr |  -.1327511     .08683    -1.53   0.126    -.3029349    .0374327
         INF |   .0850776    .038538     2.21   0.027     .0095444    .1606108
         INR |  -.4779932    .2100018   -2.28   0.023    -.8895892   -.0663973
         EXR |   -1.84008    .2529379   -7.27   0.000    -2.335829   -1.344331
         UNR |  -3.991447   1.549784    -2.58   0.010    -7.028967   -.9539264
        SIZE |  -.1123677    .0665471   -1.69   0.091    -.2427975    .0180622
         CAR |  -.0830715    .0192086   -4.32   0.000    -.1207197   -.0454234
        BKEF |  -.8082228    .2015029   -4.01   0.000    -1.203161   -.4132845
         LLP |   1.138896     .403348    2.82   0.005     .3483483    1.929443
       _cons |   13.59364    7.634115    1.78   0.075    -1.368949    28.55623
-------------+----------------------------------------------------------------
     sigma_u |  .86848693
     sigma_e |  1.1857001
         rho |  .34917392   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Appendix 2.1 – Results for Model 2

```
. xtreg NPL GDPr INF INR EXR UNR SIZE CAR BKEF LLP OWN, re

Random-effects GLS regression                   Number of obs      =       342
Group variable: bank                            Number of groups   =        64

R-sq:  within  = 0.5310                         Obs per group: min =         3
       between = 0.3461                                        avg =       5.3
       overall = 0.4613                                        max =        10

                                                Wald chi2(10)      =    335.54
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

NPL	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
GDPr	-.1343991	.0870706	-1.54	0.123	-.3050544	.0362562
INF	.0782006	.0387887	2.02	0.044	.0021761	.1542252
INR	-.4775727	.2107897	-2.27	0.023	-.8907129	-.0644326
EXR	-1.690927	.2593421	-6.52	0.000	-2.199228	-1.182626
UNR	-4.295265	1.560866	-2.75	0.006	-7.354506	-1.236024
SIZE	-.2412012	.0858168	-2.81	0.005	-.409399	-.0730034
CAR	-.089024	.0190152	-4.68	0.000	-.1262931	-.0517549
BKEF	-.855666	.1996636	-4.29	0.000	-1.246999	-.4643326
LLP	1.099473	.3994716	2.75	0.006	.3165226	1.882423
OWN	1.314708	.5850396	2.25	0.025	.1680519	2.461365
_cons	18.32198	7.905302	2.32	0.020	2.827877	33.81609

sigma_u	.80624661	
sigma_e	1.1857001	
rho	.31617675	(fraction of variance due to u_i)

Appendix 3- Results for Model 3

```
. xtreg NPL GDPr INF INR EXR UNR SIZE CAR BKEF LLP OWN GFC08, re

Random-effects GLS regression                   Number of obs      =       342
Group variable: bank                            Number of groups   =        64

R-sq:  within  = 0.5311                         Obs per group: min =         3
       between = 0.3459                                        avg =       5.3
       overall = 0.4612                                        max =        10

                                                Wald chi2(11)      =    334.99
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

NPL	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
GDPr	-.134815	.0871504	-1.55	0.122	-.3056267	.0359966
INF	.07481	.0532069	1.41	0.160	-.0294737	.1790936
INR	-.4755974	.2118908	-2.24	0.025	-.8908958	-.0602991
EXR	-1.672135	.3413195	-4.90	0.000	-2.341108	-1.003161
UNR	-4.315814	1.578611	-2.73	0.006	-7.409836	-1.221793
SIZE	-.2406186	.0865784	-2.78	0.005	-.4103092	-.070928
CAR	-.088933	.0191249	-4.65	0.000	-.1264171	-.0514489
BKEF	-.8537638	.2003648	-4.26	0.000	-1.246471	-.461056
LLP	1.098684	.4015753	2.74	0.006	.3116104	1.885757
OWN	1.312445	.5897239	2.23	0.026	.156607	2.468282
GFC08	-.0311241	.3305272	-0.09	0.925	-.6789456	.6166973
_cons	18.54765	8.34112	2.22	0.026	2.199356	34.89594
sigma_u	.81601424					
sigma_e	1.1879085					
rho	.32059573	(fraction of variance due to u_i)				